Site Reassessment

Richmond Ice Plant
Richmond, Kentucky Madison County
KYD042943217
AI: 51865
Mars# D780

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Revision (0)

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1.0 Introduction

Under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), the Kentucky Department for Environmental Protection (KDEP) conducted a Site Reassessment (SRA) at the Richmond Ice Plant in Richmond, Madison County, Kentucky .

A Preliminary Assessment was conducted in September 1987. This SRA discusses the area identified as a pond behind the plant. The pond was formerly used as the water source for the site to manufacture ice. The site was identified by the KDEP Frankfort Regional Office (FRO) during a complaint investigation in 1973 (Ref. 4). An oily substance was found on the shore of the pond and a sheen was on the water surface. The FRO initially responded to a complaint of open dumping and odors in 1973 and inspected the site numerous times during the filling and abandonment of the pond which was completed in 1974 (Ref. 4).

This SRA was conducted using the *Hazard Ranking System* (HRS) as an evaluation tool as well as the documents titled *Pre-CERLCIS Screening Assessment: Guidance Manual,* U.S. Environmental Protection Agency (EPA), Region IV Superfund Evaluation Section, August 2006, and *Guidance for Performing Preliminary Assessments under CERCLA,* EPA, September 1991, as guides for this SRA (Refs. 1-3).

The scope of this SRA included a review of available file documentation, data, on-site reconnaissance and a review of existing targets and pathways and will concentrate on the pond area of the site.

2.0 Site Reconnaissance and Trip Documentation

The Richmond Ice Plant property is located at 816 Heath Street, Richmond, Kentucky (App. A, Fig. 1). The site is approximately 2.8 acres in size with the former pond occupying approximately three-quarters of an acre. The site is bordered by a concrete plant (which appears to be inactive) and the CSXT Railway to the west, Big Hill Avenue and a mix of commercial and residential properties to the east, additional commercial properties to the north and an unnamed stream at the base of a 15 foot embankment to the south (Ref. 4; App. A, Fig. 1; App. B). The site can be accessed by vehicle from the north via Heath Street. The site is an open field with no access restrictions (App. B).

The following GPS information and reference points obtained for the site (App. A, Fig. 1):

Table 1: Richmond Ice Plant Lexington, Kentucky Site Coordinates	
Latitude	37.740941°
Longitude	-84.287132°
Reference Point	Plant Entrance (general)
Source Map Scale	Not Applicable
GPS Type	Map Interpolation
Accuracy (meters)	Not applicable
Collection Method	Google Earth
Reference Datum	NAD83
Collection Date	5/3/2016

2.1 Ownership

Richmond Ice Plant
Private ownership

2.2 Ownership History

The Richmond Ice Plant began operation as early as 1905. Deed research at the Madison County Clerk's Office revealed that the Richmond Cold Storage and Ice Company went bankrupt in 1905 and was auctioned by Master Commissioner's Sale to the Richmond Ice Company. The Richmond Ice Company then transferred the ownership of the property to a private individual in 1970 (App. B; Ref. 5).

3.0 Site Setting and Description

The Richmond Ice Plant is located at 816 Heath Street in Richmond, Kentucky, approximately three-quarters of a mile from downtown (App. A, Fig. 1). The surrounding area is a mixture of industry and residential neighborhoods (App. B). No residences, day cares or elder cares lie within 200 feet of the site boundary (App. A, Fig. 1; App B). Approximately 11,792 people live within 1 mile of the site (Ref. 6). The 1987 Preliminary Assessment (PA) indicated that a population of 21,907 people resided within a one-mile radius (Ref. 4.

The city of Richmond lies within the humid subtropical climate zone with temperatures ranging from -20°F to 105° F. The monthly mean average temperature ranges from 31.4˚ F in January to 75.0˚ F in July. The annual mean temperature is 54.3° F°. The annual precipitation averages 46.8 inches per year with the wettest months occurring in late spring and summer (Ref. 7).

The site is currently a vacant lot with a well vegetated cover. In 1973 KDEP FRO personnel investigated complaints of household trash being illegally dumped at the site. An oily black staining was discovered on the bank and an oily sheen was found on the surface of the water near the bank (Ref. 4, App. B). A slimy substance was also observed but no additional description was provided. An inspection conducted by KDEP FRO personnel in 1978 indicated the site had been filled with dirt and concrete and no garbage was visible (Ref. 4). The building was demolished sometime between 1997 and 2007 (Ref. 8).

The site lies in the USGS Richmond South Kentucky 7.5 minute topographic quadrangle (Ref. 9). The area is situated on Ordovician age deposits of the Drakes Formation. The Drakes Formation consists of grayish-green dolomitic and limy mudstones interbedded with sparsely fossiliferous dolostones. The Drakes ranges from 120 to 150 feet in thickness (Ref. 10, App. A, Fig. 2). The Drakes forms steep and cliffy slopes along large streams with dolostone/limestone slabs left as a result of weathering of the shales (Ref. 10).

The Drakes can yield 100 to 500 gallons of water per day from wells drilled in broad valley bottoms and along streams in upland areas. Almost no water is produced in wells drilled along ridgetops or on hillsides. Small springs can be found along bedding planes between the shales and dolostone/limestone layers. Water from the Drakes Formation is typically hard and may contain salts or hydrogen sulfide. The shale beds limit the amount of water available to the limestone beds; therefore little to no dissolution occurs in these units limiting the number of openings for water flow (Ref. 10).

The dominant surface water system for the area is Otter Creek. Surface water flows across the site to an unnamed stream/drainage feature which flows northeast to Otter Creek. Otter Creek then flows north, northwest toward the Kentucky River (App. A, Fig. 4; App. B). The site does not lie within the 100 or 500 year flood plain (App. A, Fig. 3).

Soils at the site are described as Caleast silt loam. The Caleast silt loam consists of deep to very deep well drained soils which formed as a result of the weathering of the underlying Drakes Formation dolostone/ limestones. The pond area, which is the area of discussion in this report, was filled with concrete debris and soil hauled from offsite (Ref. 12). The pond was constructed to serve as a water source for commercial scale ice production around 1905 (Ref. 13).

3.1 Operational History

The Richmond Ice Company historically manufactured ice for public consumption and cold storage. The dates of the original ice company, The Richmond Cold Storage and Ice Company (RCSIC), could not be determined. The RCSIC declared bankruptcy in 1905 and was sold by a Master Commissioner's Sale. The Richmond Ice Company bought the property in 1905 and operated the ice plant until the 1980's. The property was sold to a private individual in 1970. The building was demolished between 1997 and 2007 (Ref. 4; App. B). Based on newspaper articles in the Richmond Register, a local newspaper, the pond was reportedly built in 1905 as source water for the ice plant (Ref. 13). The pond was used as the source water for the ice plant until 1973 at which time the plant switched to a municipal supply (Ref. 4).

The owner of the property began abandonment of the pond in 1973. In 1973 Frankfort Regional Office personnel responded to a complaint of pollutants being dumped into the pond. An inspection conducted by FRO personnel and Madison County Health Department (MCHD) personnel confirmed part of the pond's bank and water surface was impacted by a black oily substance as well as a "slimy substance". Household trash and other refuse were also noted during the site visit (Ref. 4). The release was discussed with the property owner who denied any knowledge of the oil or other refuse being dumped at the site. He stated that he was indeed filling in the pond with dirt and concrete material, i.e. demolition debris. The inspectors noted a small stream feeding the pond from the south and west. The stream flows along the drainage area of the CSXT Railroad. The property owner indicated the unnamed stream would be redirected along the edge of the area so as not to flow through the fill (Ref. 4).

Inspectors from the FRO and MCHD indicated that the owner could fill in the pond using rock, concrete and dirt only and was given a copy of the solid waste disposal laws and regulations. A Notice of Violation was issued in April 1973 and a letter requesting a corrective action plan and schedule be submitted was sent to the owner (Ref. 4).

The site was inspected again in April 1978 and the pond was filled in and graded but the perimeter of the site was not in acceptable condition and open dumping was still occurring. The owner was once again informed that he was in violation of solid waste regulations and was given a permit application. No further information concerning the site could be located in KDWM or MCHD files.

A Preliminary Assessment (PA) site visit was conducted in August of 1987 by KDEP personnel. No municipal or industrial waste was noted during the site visit and appeared to be completely reclaimed with adequate cover and vegetation (Ref. 4).

The site visit in May 2016 for the SRA confirmed the site was still adequately covered with a good vegetative cover. No waste, residential or industrial, was noted at the site (App. B).

3.2 Waste Characteristics

Specific information regarding the operations and the waste streams at this specific site are not available; however general information is known regarding the manufacture of ice. This operation was known to use ammonia gas as the refrigerant gas. The ammonia gas was compressed into a liquid form and distributed via piping through the ice plant in a closed loop operation, which in turn froze the water as it circulated through the system (Ref. 5). Any release of ammonia gas would evaporate quickly and leave behind no residual traces. Ammonia does not last long in the environment because it is recycled naturally by plants and other organisms quickly (Ref. 19).

The primary focus of this SRA is the pond behind the Former Richmond Ice Plant. Based on previous site visits and documentation the only chemical of concern was related to the oil (presumably used oil) found on the bank of the pond and as a sheen on the surface of the water. A slimy substance was noted in the original 1973 site visit report but no description or analysis of the material is available (Ref. 4). Primary constituents of concern in used oil include polycyclic aromatic hydrocarbons (PAHs) and lead (Ref. 20).

4.0 Pathway Evaluation

4.1 Groundwater Migration Pathway

The site is underlain by Ordovician age limestones and shales of the Drakes Formation. Wells drilled in the valleys and along streams may yield 100 to 500 gallons of water per day. This water is usually hard and may contain salts or hydrogen sulfide limiting its potable use. The shales of this unit limit the transmissivity of the water to the lower limestone beds, which in turn limits the available solution enlarged openings in the limestone. The lack of enlarged fractures and pore spaces limits the amount of groundwater available in the thick limestone beds (Ref. 11).

Drinking water is supplied by the Richmond Water Works whose source water is the Kentucky River. The surface water intake for the Richmond Water Works is located at Pool 11 approximately 11 miles east and upstream from the site (App. A, Fig. 6). This source is not impacted by the site.

There are no domestic use wells within the four mile radius but there is one agricultural well. Two springs lie within the four mile radius; one in the 1-2 mile radius (inactive) and one in the 2-3 mile radius (agricultural) (App. A, Fig. 5). Well and Spring Inventories are listed in Tables 2 and 3 below:

Table 2:
Well Inventory

Distance	Well #	Estimated Population Served	Type
0 – ¼	0	0	N/A
¼ - ½	0	0	N/A
½ - 1	0	0	N/A
1 – 2	0	0	N/A
2 - 3	0	0	N/A
3 - 4	1	0	Agricultural

Table 3:
Spring Inventory

Distance	Spring #	Estimated Population Served	Type
0 – ¼	0	0	N/A
¼ - ½	0	0	N/A
½ - 1	0	0	N/A
1 – 2	1	Inactive	Inactive
2 - 3	1	0	Agriculture
3 - 4	0	0	N/A

A release from this site has a very low potential to impact the groundwater at this site. KDEP does not consider the Groundwater Migration Pathway a concern due to the lack of groundwater users.

4.2 Surface Water Migration Pathway

The site is currently covered with a vegetative cap (Ref. 4). United States Geological Survey (USGS) maps show the original stream location and the pond located on the back half of the property. The unnamed stream fed the pond and exited the site through a manmade culvert under US Highway 25, also known as Big Hill Avenue (App. A, Fig. 1; Ref. 4). Before the pond was abandoned the owner re-routed the unnamed stream to flow along the southern boundary of the current site (Ref. 4).

The site receives approximately 46 inches of precipitation annually with a monthly mean of approximately 3.9 inches (Ref. 7). The 2-year, 24 hour rainfall frequency for Madison County is 2.6 inches (Ref. 16). The site does not lie within the 100 or 500 year floodplain (App. A, Fig. 3).

4.2.1 Overland Flow Route

The Overland Flow Route is the migration route that runoff would follow from a particular onsite source to a perennial surface water body (Refs. 1-3). Furthermore, any point at which site run-off enters a perennial surface water body is considered a Probable Point of Entry (PPE).

As shown in the site photos (App. B) and the site map (App. A, Fig. 1) the run-off from the current site flows (direction to direction) via limited sheet flow across the site. The vegetative cover inhibits the sheet flow so little to no erosion occurs. The surface water run-off is directed to the unnamed stream to the south of the site. Due to overland sheet flow across the site, the entire southern boundary, approximately 450 feet, is considered the PPE. The unnamed stream then flows east through a covered culvert under Big Hill Avenue. The stream continues to flow through residential and light commercial areas until it joins Otter Creek approximately two miles from the site. Otter Creek then flows north-northwest for approximately 12 miles where it joins the Kentucky River (App. A, Fig. 4).

4.2.2 Target Distance Limit

The Surface Water Target Limit (TDL) is the migration route that site generated run-off would follow from the point it enters a perennial surface water body (PPE) to a point 15 miles downstream of the PPE (Refs. 1, 2). As stated above the unnamed stream enters Otter Creek approximately two miles from the site. Otter Creek flows north north-west approximately 12 miles where it joins the Kentucky River. The 15- mile TDL is completed in the Kentucky River (App. A, Fig. 4).

4.2.3 Surface Water Targets

There is one surface water intake within the 15-mile TDL. Winchester Municipal Utilities has a drinking water intake in the Kentucky River approximately 14.7 miles downstream from the site. This intake supplies 74% of the source water for the City of Winchester and serves a population of 14,168 in Clark County (App. A, Fig. 6; Ref. 17).

There are approximately 2.16 total miles of Palustrine (PFO1A,h) wetlands, 5.3 miles of Riverine (R3RBH) wetlands and 2.5 miles of Lacustrine (L1UBHh) wetlands along the 15-mile TDL. The Palustrine wetlands are forested with broadleaf deciduous trees and temporarily flooded, emergent wetlands that are seasonally flooded, and scrub-shrub wetlands that are temporarily and seasonally flooded (App. A, Fig. 4). The nearest Palustrine wetland is approximately four miles from the site along Otter Creek (App. A, Fig. 4).

There are federally and state listed endangered or threatened species in Madison County. Table 3 lists these species and their status (Ref. 18):

Table 4:
Endangered and threatened Species

Scientific Name	Common Name	Class	US Status	State Status
Accipiter striatus	Sharp-shinned Hawk	Aves	N	S
Actitis macularius	Spotted Sandpiper	Aves	N	E
Ammodramus henslowii	Henslow's Sparrow	Aves	N	S
Anas clypeata	Northern Shoveler	Aves	N	E
Anas discors	Blue-winged Teal	Aves	N	T
Asio flammeus	Short-eared Owl	Aves	N	E
Asio Otus	Long-eared Owl	Aves	N	E
Bubulcus ibis	Cattle Egret	Aves	N	S
Certhia Americana	Brown Creeper	Aves	N	E
Chondestes grammacus	Lark Sparrow	Aves	N	T
Circus cyaneus	Northern Harrier	Aves	N	T
Cistothorus platensis	Sedge Wren	Aves	N	S
Corynorhinus rafensquii	Rafinesque's Big-eared Bat	Mammalia	N	S
Cryptobrabchus alleganiensis alleganiensis	Eastern Hellbender	Amphibia	N	E
Eumeces anthracinus	Coal Skink	Reptilia	N	T
Falco peregrinus	Peregrine Falcon	Aves	N	E
Fulcia americana	American Coot	Aves	N	E
Gallinula galeata	Common Gallinule	Aves	N	T
Junco hyemalis	Dark-eyed Junco	Aves	N	S
Lophodytes cucullatus	Hooded Merganser	Aves	N	T
Mustela nivalis	Least Weasel	Mammalia	N	S
Myotis grisescens	Gray Myotis	Mammalia	E	T
Myotis septentrionalis	Northern Myotis	Mammalia	T	E
Nycticeius humeralis	Evening Bat	Mammalia	N	S
Pandon haliaetus	Osprey	Aves	N	S
Passerculus sandwichensis	Savannah Sparrow	Aves	N	S
Peucaea aestivalis	Bachman's Sparrow	Aves	N	E

Phaloacrocorax auritus	Double-crested Cormorant	Aves	N	T
Podilymbus podiceps	Pie-billed Grebe	Aves	N	E
Pseudoanophthalmus catoryctos	Lesser Adam's Cave Beetle	Insecta	N	E
Pseudoanophthalmus pholeter	Greater Adam's Cave Beetle	Insecta	N	E
Rana pipiens	Northern Leopard Frog	Amphibia	N	S
Sitta canadensis	Red-breasted Nuthatch	Aves	N	E
Thryomanes bewickii	Bewick's Wren	Aves	N	S
Tyto alba	Barn Owl	Aves	N	S
Ursus Americana	American Black Bear	Mammalia	N	S
Vermivora chrysoptera	Golden-winged Warbler	Aves	N	T

Federal Status Definitions: E= Endangered, T= Threatened, N= No Federal Status
State Status: E= Endangered, T= Threatened, S= Special Concern

4.2.4 Surface Water Migration Pathway Conclusions

There is one surface water intake located within the 15 mile TDL. The intake serves as a drinking water source for the City of Winchester; however it is located approximately 14.7 miles from the site in the Kentucky River (App. A, Fig. 6) and as such is not likely to be affected by the site. The nearest wetland of concern is four miles downstream of the site (Refs. 1-3).

KDEP does not consider the Surface Water Migration Pathway to be a concern.

4.3 Air Migration Pathway
The Air Migration Pathway was not evaluated due to the inactivity of the site.

4.4 Soil Exposure Pathway
The Richmond Ice Plant site consists of a vacant lot covered with a well-established vegetative cover limiting direct contact with any soils at the site (Ref. 4). The soils at the site, specifically the pond discussed in this report, are a mixture of various fill materials including concrete slabs and soils. There were reports of open dumping of household trash and debris in the 1970's. No industrial waste was reported at that time with the exception of the oil on the bank and the sheen on the water. A slimy substance was also reported but no information or analytical data relating to that substance is available (Ref. 4).

Based on past interviews with the land owner by KDEP and Madison County Health Department personnel, only concrete debris and soils were used to fill in the pond (Ref. 4). Past inspectionsdocumented household trash being deposited at the site. Notices of Violation (NOVs) were issued but no record of compliance exists. Based on documentation from KDEP, the site was not required to have a solid waste permit if only concrete and soils were used to fill in the pond area. No documentation exists concerning the approval of any permit either by the Madison County Health Department or the KDEP Solid Waste program (Ref. 4). Subsequent inspections, the Preliminary

Assessment conducted in September, 1987, and the SRA site visit did not reveal any waste at the surface (Ref. 4, App. B).

The facility has been inactive sine the 1980's and the exposure pathway has been eliminated by the installation of a vegetative cap.

KDEP does not consider the Soil Exposure Pathway a concern.

5.0 Summary and Conclusions

The site was an ice plant which manufactured ice for residential and commercial use. The plant used liquid ammonia as its refrigerant in a closed loop system. The primary area of concern during the original PA was the pond located behind the old ice plant. The former pond was fed by an un-named stream which flowed along the rail bed on the west of the site from the south. The stream was redirected when the facility switched to a municipal water source and the owner decided to fill in the pond with concrete debris and soil (Ref. 4). Before the pond closure was completed open dumping of household trash and debris was reported. The KDEP Frankfort Regional Office investigated numerous reports of open dumping and on one occasion discovered a black oily substance on the bank and the water surface. A slimy substance was also found in the area but no further description of the substance was found in KDEP records (Ref. 4).

There are no groundwater users within the four mile radius to consider the Groundwater Migration Pathway a concern. The residents of Richmond are supplied with drinking water from a surface water source that is upstream and not impacted by the site (App. A, Fig. 5; Ref. 15).

The Soil Exposure Pathway was evaluated but determined to not be a concern at this time due to a well vegetated cap on the area where the pond was located. The vegetated cap limits exposure to any contaminated soil that may have existed on the pond banks (App. B).

The Air Migration Pathway was not evaluated because there are no active emissions from the facility. The Richmond Ice Plant building was demolished sometime between 1997 and 2007 (Ref. 8).

The Surface Water Migration Pathway was evaluated and determined not to be a concern due to the distances to environmentally sensitive features and lack of surface water targets. A total of 2.16 miles of Palustrine Wetlands (PFO1A,h), exists in the 15-mile TDL. The nearest wetland of concern is approximately four miles away from the site. One surface water intake exists in the 15-mile TDL; however, at 14.7 miles downstream it is not likely to be impacted by this site (App. A, Figs. 4 & 6).

There are insufficient targets and pathways to warrant further action under CERCLA, therefore, KDEP does not recommend further action at this time.

6.0 References

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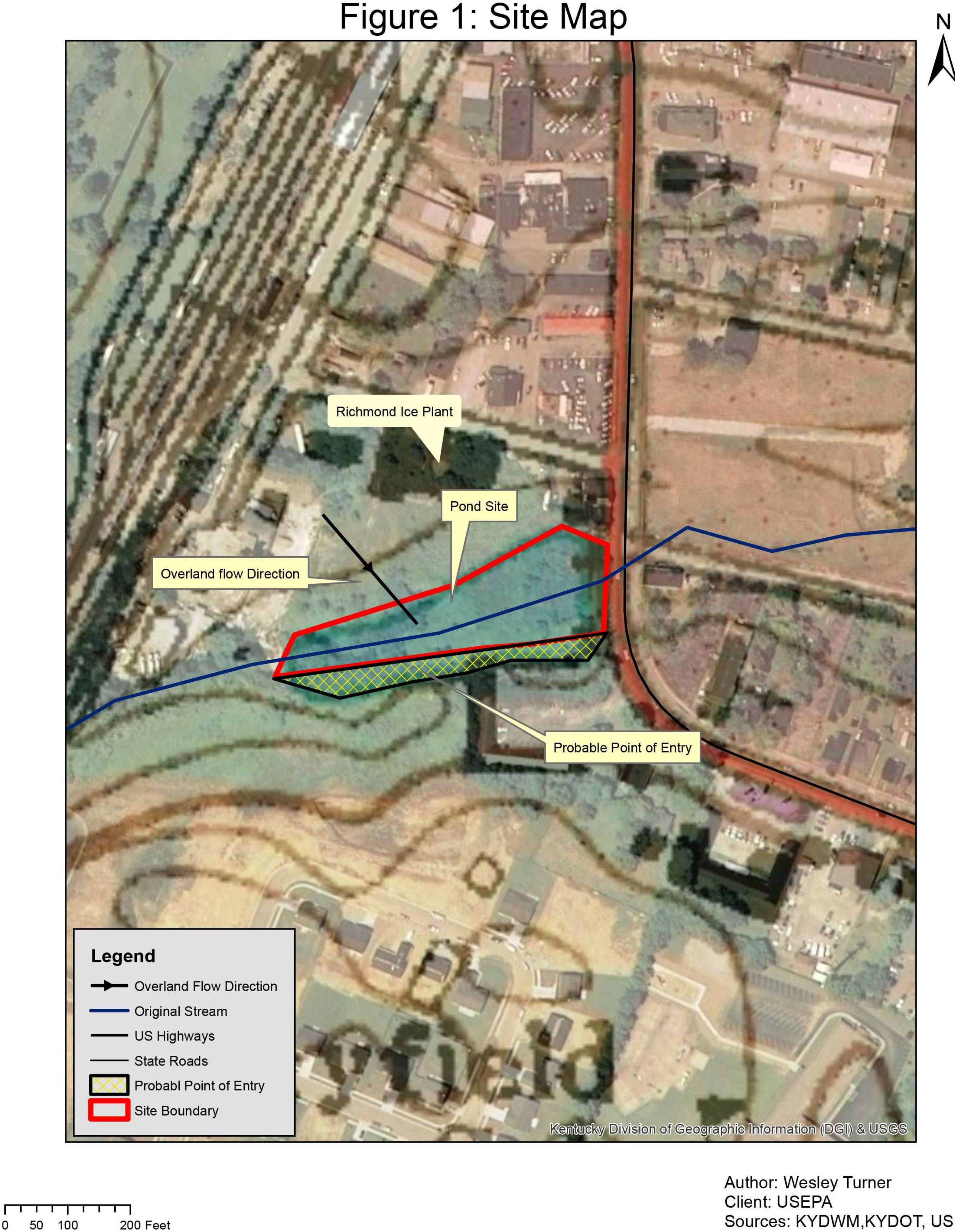
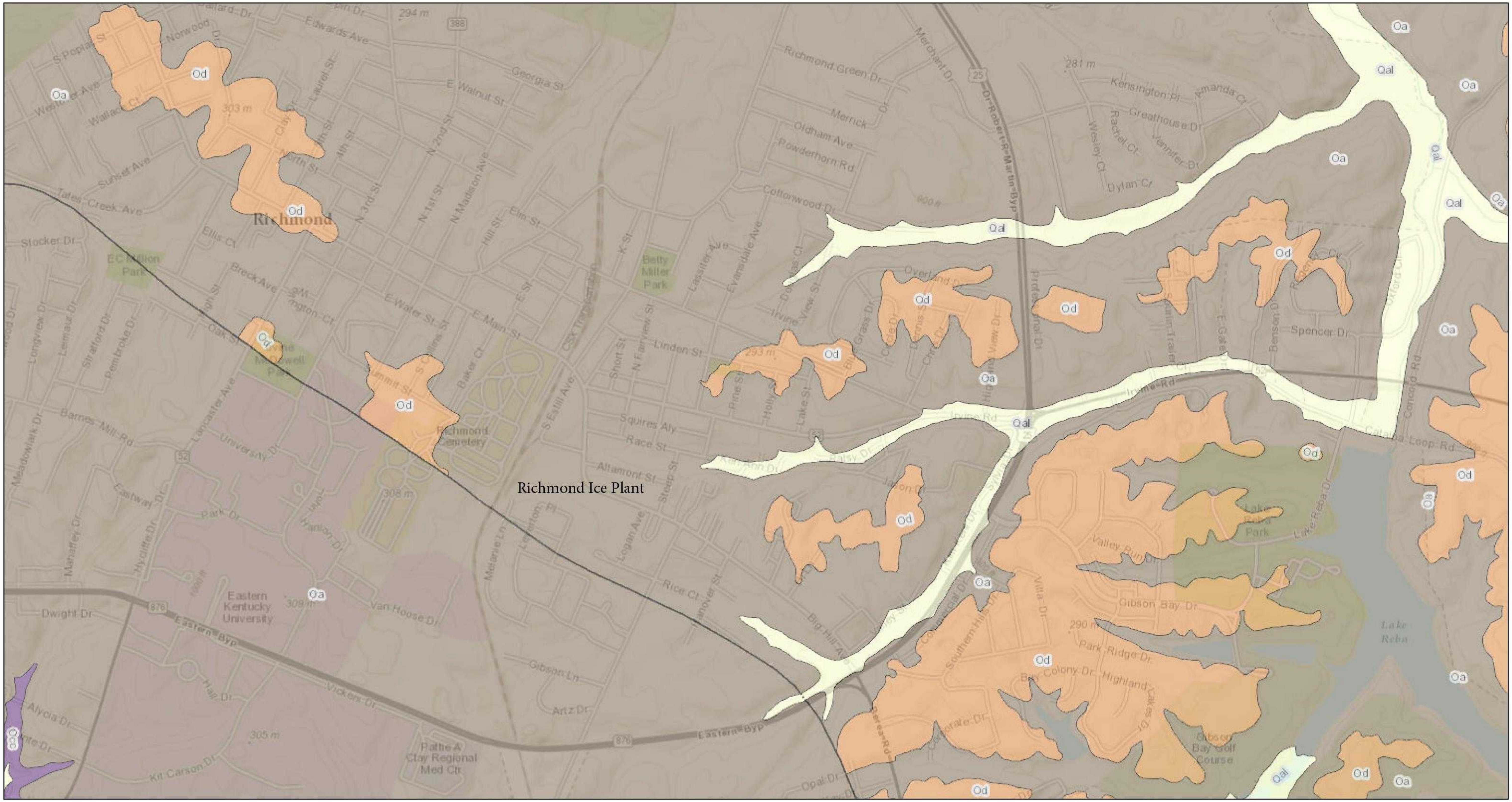
Appendix A

Figure 1: Site Map



Author: Wesley Turner
Client: USEPA
Sources: KYDWM,KYDOT, USGS
Date: 6/2/2016
Data is valid for date above.

Figure 2: Geologic Map



May 20, 2016

1:18,056

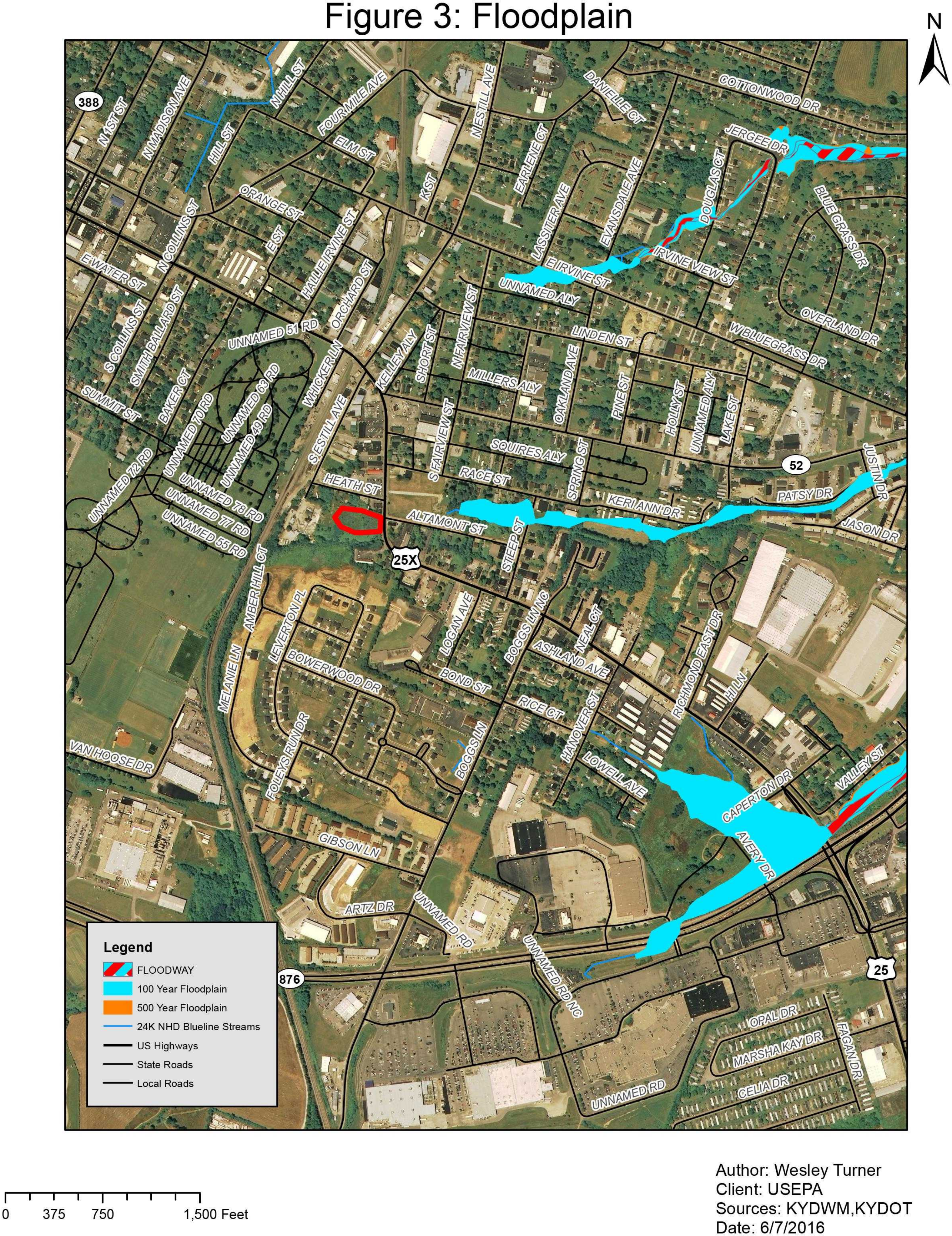
0 0.225 0.45 0.9 mi

0 0.35 0.7 1.4 km

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

author: Kentucky Geological Survey

Figure 3: Floodplain



Author: Wesley Turner
Client: USEPA
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Date: 6/7/2016
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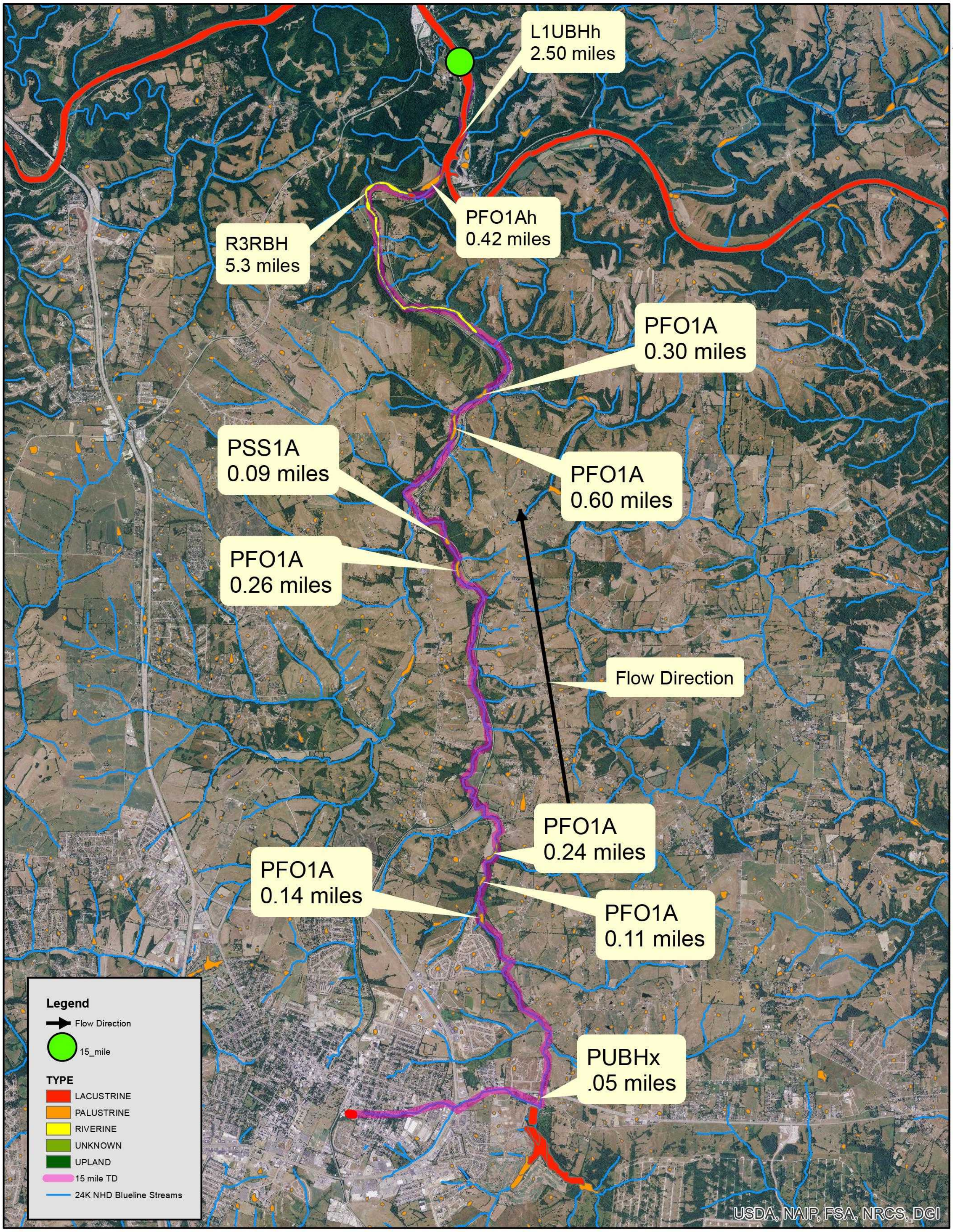
Figure 4: 15 Mile Target Distance Limit

N

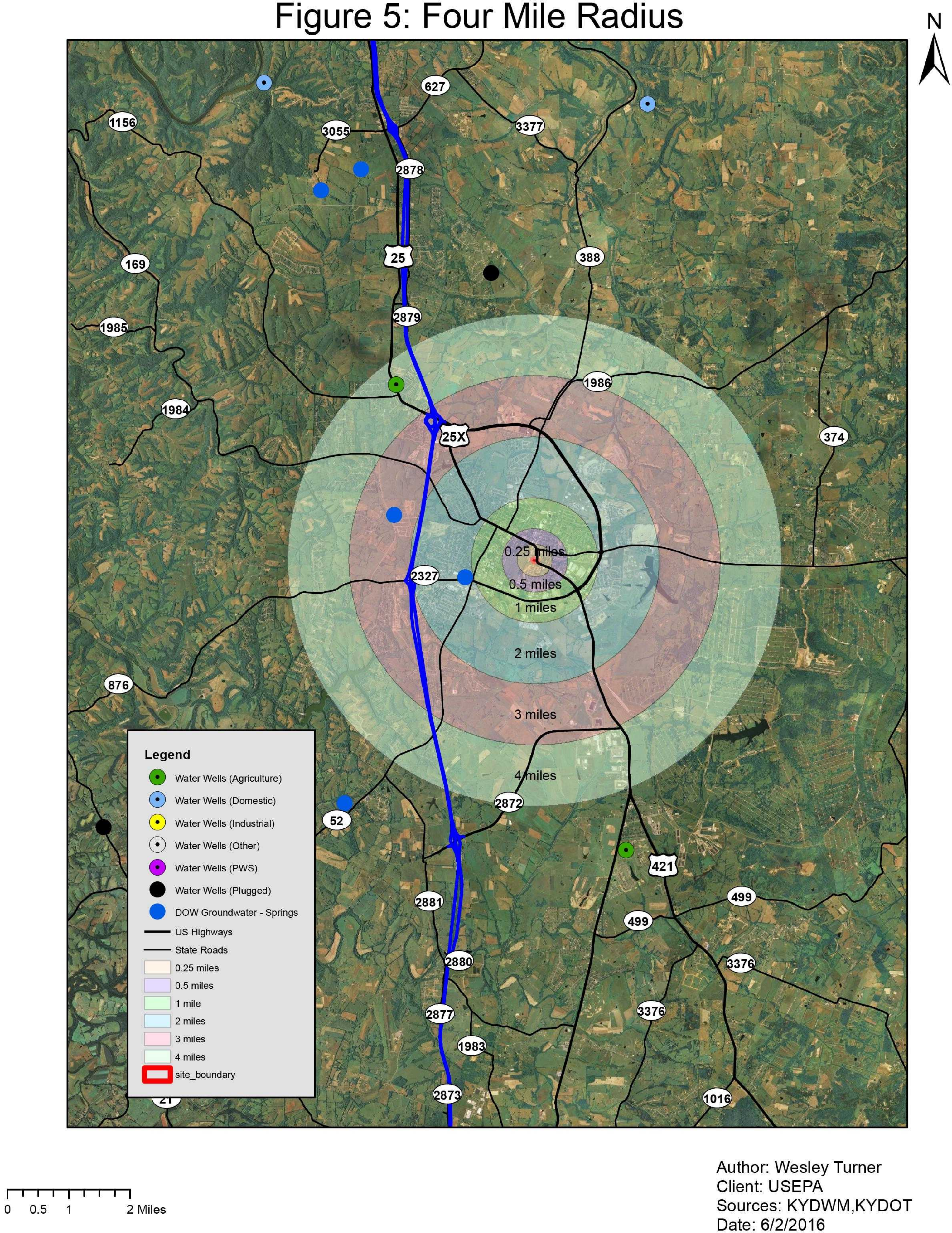


0 0.5 1 2 Miles

2.16 total miles of Palustine Wetlands

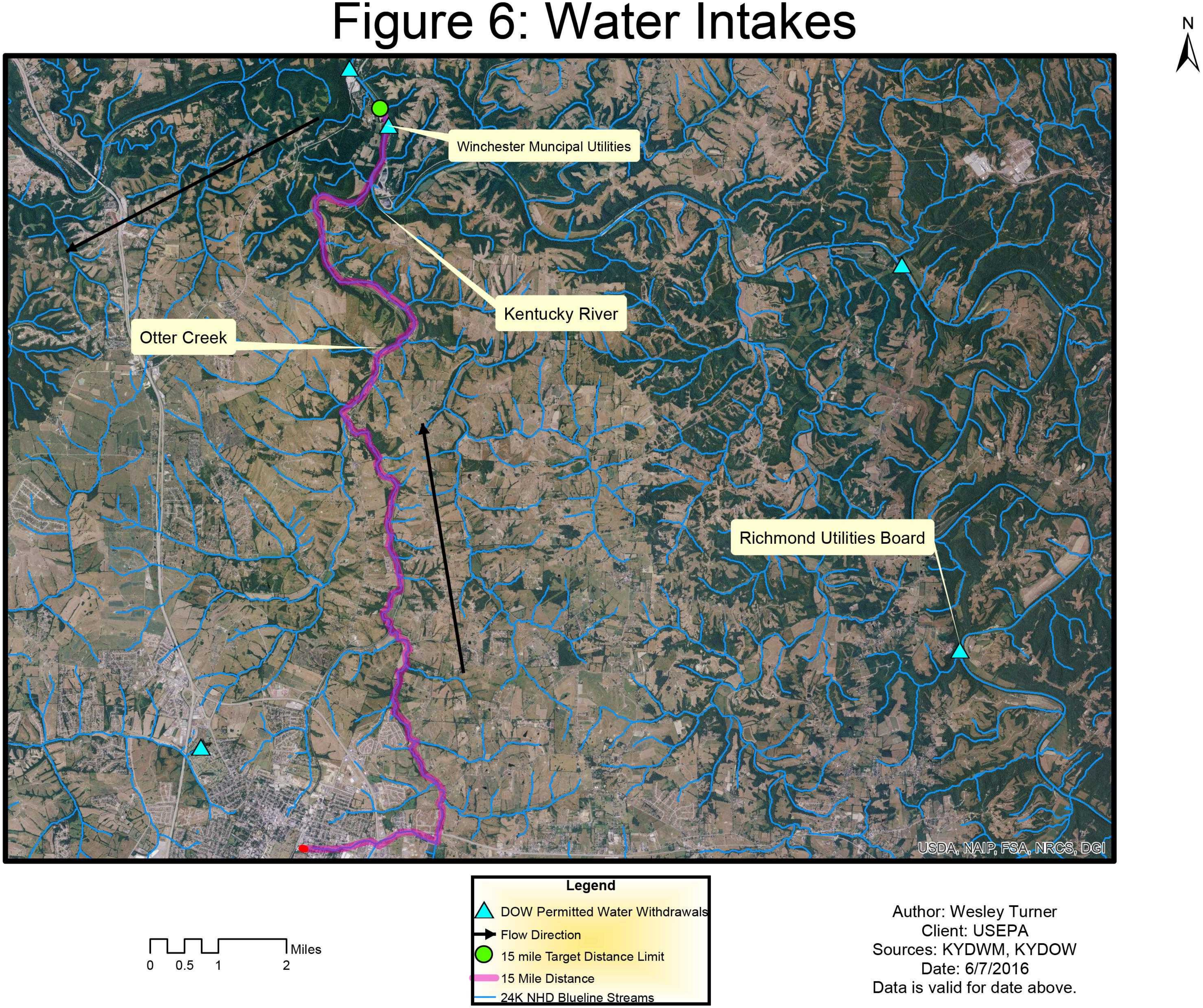
Author: Wesley Turner
Client: USEPA
Sources: KYDWM,KYDOT, NWI
Date:5/31/2016
Data is valid for date above.

Figure 5: Four Mile Radius



Author: Wesley Turner
Client: USEPA
Sources: KYDWM,KYDOT
Date: 6/2/2016
Data is valid for date above.

Figure 6: Water Intakes



Author: Wesley Turner
Client: USEPA
Sources: KYDWM, KYDOW
Date: 6/7/2016
Data is valid for date above.

Appendix B

Site Trip Map

Photos

Site Trip Report

Richmond Ice Plant
General site information
Legend
Nearest residence.
Richmond Ice Plant
Richmond Ice Plant Boundary
Stream Path
Heath St
Richmond Ice Plant
Big Hill Ave
Google earth
© 2016 Google
500 ft

Richmond Ice Plant

Looking east down Heath Street toward Big Hill Avenue. Commercial structures are to the north (left of photo) and east (center of photo). No residential properties are within 200 feet of the facility boundaries.

1 of 10

Richmond Ice Plant

Close up views of commercial structures across from entrance to Richmond Ice Plant looking north.

2 of 10

Richmond Ice Plant

Entrance to former parking lot for the Richmond Ice Plant.

3 of 10

Richmond Ice Plant

Looking west along Heath Street from front of the facility. Commercial structures occupy Heath Street across from the Ice Plant. At the end of Heath Street are railroad tracks and a inactive concrete facility.

Richmond Ice Plant

Standing on Heath Street facing south looking across the vegetative cover and former parking area for the ice plant. The group of shrubs on the right side of the photo is an old loading ramp.

Richmond Ice Plant

Household trash found on the site. It appeared to have been deposited there fairly recently.

6 of 10

Richmond Ice Plant

Concrete debris scattered across the site. This is an algal mat that formed due to low permeability and standing water.

Richmond Ice Plant

Stream bordering southern edge of property. This stream receives run-off from multiple points and properties. Litter and trash could be seen in the stream.

8 of 10

Richmond Ice Plant

Concrete construction debris located sporadically across the site.

Richmond Ice Plant

Site vegetation looking south. The stream is located just past the telephone pole. The stream surface is approximately four to feet lower than the cap surface. The trees in the back is approximately 15 feet higher in elevation.

10 of 10

Energy and Environmental Protection Cabinet
Department for Environmental Protection
Division of Waste Management

Site Trip Report

Site Permit ID: **51865**			Regional Office: **Frankfort**
Site Name: Richmond Ice Plant			Program: Superfund
Site Address: 816 Heath Street			
City: Richmond	State: Kentucky	Zip: 40475	County: Madison
Site Contact:	Title		Phone #:
Inspection Type: Comprehensive	Purpose: site recon for PASI		Not Com #:
Inspection Dates: 5 3 2016	Time: 1030 hours		
Latitude: 37.740941	Longitude: -84.287132		
Coordinate Collection Method: Digital Ortho Image Verified			
Type of Site: **former ice manufacturing plant and associated pond (building and pond are gone)**			

I. Investigation Results

Findings/Violations/Recommendations: Arrived on site at approximately 1030 hours after visiting the PVA and county clerk's office to research the deeds and ownership of the property. The original name for the site was the Richmond Cold Storage and Ice Company which went bankrupt about 1905. The facility and property was sold at auction in 1905 to the Richmond Ice Company. Richmond Ice Company transferred the property to a private party in 1970. That individual is the still the current owner of the property.

Site access is from Heath Street which runs parallel to the site and is accessed from Big Hill Avenue (Business US 25). The site is a vacant lot with a well-developed vegetative cap. The cap consists of grasses, assorted native and non- native species of plants. Based on previous aerial photos the site is mown regularly and well maintained. There were no visible signs of stressed vegetation at the site. Concrete slabs from the old parking and loading areas were still visible. Pieces of concrete slab were scattered sparsely across the site.

The site is bounded to the north by Heath Street. Across Heath Street are a number of commercial buildings. On the eastern side are a church and another commercial building. Immediately to the south is a small stream which runs along the southern border of the site. This is likely the stream that fed the pond the Ice Company used as a water source for its ice manufacturing. It is believed the stream was re-routed when the pond was filled in the 1970s. There is a change in elevation on this side of the site of about 15 feet (rise).

To the west is a concrete plant which appears to be out of business, no activity was observed at the site and the buildings were boarded up.

The stream on the southern border flows to the northeast off site under Big Hill Avenue and continues through Richmond to the east toward Lake Reba. The stream does not enter Lake Reba but flows at the base of the dam and continues to flow toward the area known as Green Crossing in Madison County.

Overland flow is to the southeast across the cap and empties into the stream. The closest residence is approximately 300 feet from the southeast corner of the facility.

Map of site attached and photos attached

Compliance Status - Not Applicable

II. Comments Including Remedial Measures and Expected Correction Dates

Comments:

III. Environmental/Human Health Impact

Findings/Violations/Recommendations:

Compliance Status - Not Applicable

IV. Documentation

- [x] Photos taken by Wesley Turner
- [ ] Record of visual determination of opacity
- [ ] Documents Obtained From Facility
- [ ] Samples taken by DEP
- [ ] Samples taken by outside source
- [ ] Regional Office instrument readings taken
- [ ] Other documentation
- [x] Site Hazard Assessment Completed

Comments:

Inspector: Wesley turner	Title: Geologist III	Date: 3 May 2016
Overall Compliance Status		
☒ **No violations observed**		
☐ **No violations observed but impending violation trends observed** – Advisory Action Taken		
☐ **Out of Compliance. Non-recurrent deficiency noted** – Verbal notice given or violation corrected at time of inspection.		
☐ **Out of Compliance. Non-recurrent administrative or O & M deficiency noted** – Warning Notice issued		
☐ **Out of Compliance** – NOV issued		

Received By:	Title:	Date:
Delivery Method:		

Reference 1

or loan guarantee or loan insurance program; and

(4) Acquisitions by or transfers to a government entity pursuant to seizure or forfeiture authority.

(b) Nothing in this section or in CERCLA section 101(20)(D) or section 101(35)(A)(ii) affects the applicability of 40 CFR 300.1100 to any security interest, property, or asset acquired pursuant to an involuntary acquisition or transfer, as described in this section.

NOTE TO PARAGRAPHS (A)(3) AND (B) OF THIS SECTION: Reference to 40 CFR 300.1100 is a reference to the provisions regarding secured creditors in CERCLA sections 101(20)(E)-(G), 42 U.S.C. 9601(20)(E)-(G). *See* Section 2504(a) of the Asset Conservation, Lender Liability, and Deposit Insurance Protection Act, Public Law, 104-208, 110 Stat. 3009-462, 3009-468 (1996).

APPENDIX A TO PART 300—THE HAZARD RANKING SYSTEM

Table of Contents

Reference 2

119

United States
Environmental Protection
Agency

Office of Emergency and
Remedial Response
Washington DC 20460

EPA/540/G-91/013
September 1991

EPA

Guidance for Performing Preliminary Assessments Under CERCLA

Reference 3

PRE-CERCLIS SCREENING ASSESSMENT

Guidance Manual

U.S. EPA Region 4 - Superfund Site Evaluation Section

August 2006

Reference 4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

DEC 2 2 2015

Mr. Daniel Phelps
Kentucky Department Environmental Protection
Division of Waste Management
200 Fair Oaks
Frankfort, Kentucky 40601

DEC 30 '15 AM10:22

RE: Freedom of Information Act Request No. EPA-R4-2016-001912

SUPERFUND BRANCH

Dear Mr. Phelps:

This letter is in response to your Freedom of Information Act (FOIA) request dated December 9, 2015, regarding Richmond Ice House, also known as, Richmond Ice Plant and Richmond Ice Company in Richmond, Kentucky. Specifically, you requested all records, for the timeframe of January 1, 1990 through December 4, 2015.

Enclosed are documents maintained by the United States Environmental Protection Agency (EPA), Region 4. The cost of providing this information is $20.45, which you authorized for payment on December 9, 2015. An itemized invoice covering the charges for processing your request is enclosed. The Fee Schedule and Payment Procedures attached to the invoice explain the interest and handling charges that will be incurred if payment is not received within 30 days. Payments are accepted through debit, credit card, check or money order. If you choose to make payment by debit or credit card, please do so by registering with www.pay.gov and selecting the EPA Miscellaneous Payment Form (SFO 1.1). If you prefer to pay by check or money order, please make it payable to the U. S. Environmental Protection Agency, within 30 days of the date of this response to the following address:

U. S. Environmental Protection Agency
FOIA and Miscellaneous Payments
Cincinnati Finance Center
P. O. Box 979078
St. Louis, Missouri 63197-9000
RE: EPA-R4-2016-001912

To ensure proper credit for your payment, your check or money order should refer to the FOI number above and should be accompanied by a copy of the enclosed Bill for Collection. Your prompt remittance of the amount indicated will be appreciated.

You may appeal response to the National Freedom of Information Officer, U. S. EPA, FOIA and Privacy Branch, 1200 Pennsylvania Avenue, N.W. (2822T), Washington, D.C. 20460, Email: hq.foia@epa.gov. Only items mailed through the United States Postal Service may be delivered to 1200 Pennsylvania Avenue, N.W. If you are submitting your appeal via hand delivery, courier service or overnight delivery, you must address your correspondence to 1301 Constitution Avenue, N.W., Room 6416J, Washington, D.C. 20004. The appeal must be made in writing, and it must be submitted no later than 30 calendar days from the date of this letter. The Agency will not consider appeals received after the 30 calendar day limit. The appeal letter should include the FOI number listed above. For quickest possible handling, the appeal letter and its envelope should be marked "Freedom of Information Act Appeal."

Should you have questions regarding this response, please contact Jennifer Pearce, FOIA Specialist, at (404) 562-8600.

Sincerely,

Vickie H. Tellis

for Kenneth R. Lapierre
Assistant Regional Administrator

Enclosures
1. Index of released documents
2. Bill for Collection
3. Fee Schedule and Payment Procedures

INDEX OF RELEASED DOCUMENTS

EPA-R4-2016-001912

09/1987 Preliminary Assessment Report

FOIA Invoice

U.S Environmental Protection Agency
1200 Pennsylvania Ave, NW
Washington, DC 20460

Mail Payment to	**FOIA Tracking Number**
USEPA, FOIA and Miscellaneous Payments, Cincinnati Finance Center P.O. BOX 979078 St. Louis, MO 63197-9000	EPA-R4-2016-001912 **Invoice Date** 12/09/2015

Requester Contact Information	**Description of Records Requested**
Daniel Phelps KDEP Division of Waste Management 200 Fair Oaks Frankfort, KY 40601 daniel.phelps@ky.gov 502-564-6716	KDEP needs copies of records (start dated 1/1/1990 to the present 12/4/2015) for the following site: Richmond Ice House Richmond, KY KYD042943217 The EPA staff contact for this work is Donna Seadler, Superfund Site Evaluation Section.

	Date	**By**
Request Received	12/08/2015	Region 4
Request Fulfilled by Agency	12/09/2015	Jennifer Pearce

Comments/Instructions

Request Fee Category

Commercial

Description of Costs	**Quantity**		**Amount (USD)**
Search	0.25	hours	$7.00
Review	0.25	hours	$7.00
Copy	43	pages	$6.45
Costs Sub-total			***$20.45***

AMOUNT DUE	**$20.45**

U.S. ENVIRONMENTAL PROTECTION AGENCY
FREEDOM OF INFORMATION
FEE SCHEDULE AND PAYMENT PROCEDURES
EFFECTIVE JANUARY 1, 2008

NOTICE TO THE REQUESTER

Payment should be made in the form of a check or money order, payable to the United States Environmental Protection Agency. To ensure proper credit of your payment, please write the Freedom of Information Act Request Identification Number (FOIA #) on your check or money order and return with the top portion of the Bill for Collection. Mail payment to :

U.S. Environmental Protection Agency
FOIA and Miscellaneous Payments
Cincinnati Finance Center
P.O. Box 979078
St. Louis, Missouri 63197-9000

In accordance with U.S. Treasury (I IFM 6-8000) and the Debt Collection Act of 1982, payment is due within 30 calendar days of the bill date. If not received within 30 days, interest at the rate of 3% which begins to accrue from the date of the bill through the date of payment, will be assessed. A late payment handling charge of $15.00 will be imposed after 30 days with an additional charge of $15.00 for each subsequent 30-day period. A 3% per annum penalty will be applied on any principal amount not paid within 90 days of the due date.

In accordance with the Freedom of Information Reform Act of 1986, you request has been categorized as:

☒ ***COMMERCIAL USE REQUEST:*** **requester charged for search, review, and duplication cost.**

☐ ***EDUCATIONAL & NON-COMMERCIAL SCIENTIFIC INSTITUTIONS:*** **requester charged for duplication cost excluding first 100 pages.**

☐ ***REPRESENTATIVE OF THE NEWS MEDIA:*** **requester charged for duplication cost excluding the first 100 pages.**

ALL OTHER REQUEST: **requester charged for search and duplication time excluding the first two (2) hours of search time and the first 100 pages of duplication.**

ATTACH TO BILL FOR COLLECTION OF PAYMENT

FOR RESPONSES TO FOIA REQUESTS

REQUESTOR Mr. Daniel Phelps
EPA-R4-2016-001912

PRELIMINARY ASSESSMENT REPORT

RICHMOND ICE COMPANY
RICHMOND, MADISON COUNTY, KENTUCKY

BY
JON MAYBRIAR
UNCONTROLLED SITE SECTION
DIVISION OF WASTE MANAGEMENT

SEPTEMBER, 1987

TABLE OF CONTENTS

APPENDICES

A- EPA Preliminary Assessment Form 2070-12
B- Preliminary HRS Score Sheet
C- Maps
D- Site Visit Memo
E- Photographs
F- Population data documentation on surface and Groundwater Usage documentation
G- Water Usage

HISTORY OF SITE

The Richmond Ice Company is located at 816 Heath Street in Richmond, Kentucky (Appendix C). The plant commercially manufactures ice for Richmond and surrounding areas. The operation began in 1959 and is currently owned by Marsh Orwtenburger and Marylin Williams. Prior to 1973, the ice company utilized a lake on their property as a water source for making ice, but in May 1973 switched to a municipal water supply for their ice production. The lake was to be filled in with dirt only and required no solid waste permit. On April 13, 1973, a site investigation by KDWM personnel found a small oil slick on the lake, a slimy substance on the bank, and some municipal garbage around the lake (Appendix D). By May 1978, the lake had been filled and graded. On the August 24, 1987, Preliminary Assessment (PA) site visit, no municipal garbage or industrial waste was observed. The site appeared to be completely reclaimed with adequate cover and vegetation over the site (Appendix E). If industrial waste was taken to this site, toluene would be a typical contaminant and resulted in it being chosen for ranking purposes.

ROUTE OF CONTAMINATION

The site is located on the border of the Inner Bluegrass and the eastern Knobs Region and is approximately three (3) acres in size and relatively level. Soils at the site are the Caleast Series and are the deep well-drained soils that form in residuum from limestone. Due to high fertility and permeability, soils around the site have a high crop production rate.

Rocks in the area are in the Upper Ordivician System and bedrock can be found eight (8) to ten (10) feet beneath the surface in the Ashlock Formation. This formation consist of alternate layers of dolomite, shale, and limestone (USGS-1966).

The aquifer of concern can be found 125 feet beneath the site in the Maysville Group. Wells in this group yield 100 to 500 gallons per day (gpd) in broad valley bottoms and along streams but almost no water to wells on hillsides or ridges (USGS-1960).

POSSIBLE AFFECTED POPULATION AND RESOURCES

Population within a one (1) mile radius of the site is estimated to be 21,907 people. There are an estimated 30,054 residents living within a three (3) mile radius and 30, 746 people residing within a four (4) mile radius of the site (Appendix F).

Drinking water for Richmond is supplied by Richmond Water, Gas and Sewage Works. Their water intake is upgradient on the Kentucky River. There are no surface water intakes fifteen (15) mile downgradient of the site. An estimated 217 residents utilize groundwater within a three (3) mile radius of the site (Appendix G).

REFERENCES

Kentucky Department of Economic Development, " Resources for Economic Development Richmond, Kentucky". The Richmond Chamber of Commerce, 1986.

Kentucky Division of Waste Management Files on Richmond Ice Company.

USGS, 1960. Availability of Groundwater in Clark, Estill, Madison and Powell Counties.

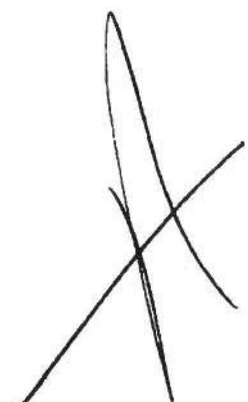
USGS, 1967. Geological Map of the Union City Quadrangle, Madison and Clark Counties, Kentucky.

USGS, 1952. Photorevised 1979, Moberly Quadrangle, 7.5 Minute Series Topographic Map.

USGS, 1965. Photorevised 1979, Richmond North Quadrangle, 7.5 Minute series topographic Map.

USGS, 1965. Photorevised 1979, Richmond South Quadrangle, 7.5 Minute Series Topographic Map.

USGS, 1952. Photorevised 1979, Union City Quadrangle, 7.5 Minute Series topographic Map.



EPA

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 1 - SITE INFORMATION AND ASSESSMENT

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
KY	New Site

II. SITE NAME AND LOCATION

01 SITE NAME (Legal, common, or descriptive name of site): Richmond Ice Company

02 STREET, ROUTE NO., OR SPECIFIC LOCATION IDENTIFIER: 816 Heath Street

03 CITY: Richmond

04 STATE: Ky | 05 ZIP CODE: 40475 | 06 COUNTY: Madison | 07 COUNTY CODE: 151 | 08 CONG DIST: 05

09 COORDINATES LATITUDE: 37°44'26".2 LONGITUDE: 84°16'03".5

10 DIRECTIONS TO SITE (Starting from nearest public road): OFF BIG HILL AVE. BEHIND RICHMOND ICE PLANT

III. RESPONSIBLE PARTIES

01 OWNER (if known): Marsh Orwtenburger

02 STREET (Business, mailing, residential): 352 High

03 CITY: Richmond

04 STATE: KY | 05 ZIP CODE: 40475 | 06 TELEPHONE NUMBER: (606) 623-6990

07 ~~OPERATOR~~ owner (if known and different from owner): Marylin Williams

08 STREET (Business, mailing, residential): 103 Bob-o-link

09 CITY: Richmond

10 STATE: KY | 11 ZIP CODE: 40475 | 12 TELEPHONE NUMBER: (606) 624-9589

13 TYPE OF OWNERSHIP (Check one)

☑ A. PRIVATE ☐ B. FEDERAL: ______ (Agency name) ☐ C. STATE ☐ D. COUNTY ☐ E. MUNICIPAL

☐ F. OTHER: ______ (Specify) ☐ G. UNKNOWN

14 OWNER/OPERATOR NOTIFICATION ON FILE (Check all that apply)

☐ A. RCRA 3001 DATE RECEIVED: __/__/__ (MONTH DAY YEAR) ☑ B. UNCONTROLLED WASTE SITE (CERCLA 103 c) DATE RECEIVED: __/__/__ (MONTH DAY YEAR) ☐ C. NONE

IV. CHARACTERIZATION OF POTENTIAL HAZARD

01 ON SITE INSPECTION

☑ YES DATE 08/24/87 (MONTH DAY YEAR)
☐ NO

BY (Check all that apply)

☐ A. EPA ☐ B. EPA CONTRACTOR ☑ C. STATE ☐ D. OTHER CONTRACTOR

☐ E. LOCAL HEALTH OFFICIAL ☐ F. OTHER: ______ (Specify)

CONTRACTOR NAME(S): ______

02 SITE STATUS (Check one)

☐ A. ACTIVE ☑ B. INACTIVE ☐ C. UNKNOWN

03 YEARS OF OPERATION: 1973 (BEGINNING YEAR) | 1978 (ENDING YEAR) ☐ UNKNOWN

04 DESCRIPTION OF SUBSTANCES POSSIBLY PRESENT, KNOWN, OR ALLEGED

Oily & Slimy Substances noted on bank of pond being filled with garbage.

05 DESCRIPTION OF POTENTIAL HAZARD TO ENVIRONMENT AND/OR POPULATION

Unknown

V. PRIORITY ASSESSMENT

01 PRIORITY FOR INSPECTION (Check one. If high or medium is checked, complete Part 2 - Waste Information and Part 3 - Description of Hazardous Conditions and Incidents)

☐ A. HIGH (Inspection required promptly) ☐ B. MEDIUM (Inspection required) ☑ C. LOW (Inspect on time available basis) ☐ D. NONE (No further action needed, complete current disposition form)

VI. INFORMATION AVAILABLE FROM

01 CONTACT	02 OF (Agency/Organization)	03 TELEPHONE NUMBER
Karen Glancy	KDWM Field office	(606) 784-6634

04 PERSON RESPONSIBLE FOR ASSESSMENT	05 AGENCY	06 ORGANIZATION	07 TELEPHONE NUMBER	08 DATE
Jon Maybriar	KYNREPC KDWM	Div of Waste Mgt PA/SI CERCLA	( )	08/21/87

EPA FORM 2070-12 (7-81)

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT PART 2 - WASTE INFORMATION

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER
KY	New Site

II. WASTE STATES, QUANTITIES, AND CHARACTERISTICS

01 PHYSICAL STATES (Check all that apply)

- ☐ A. SOLID
- ☐ B. POWDER, FINES
- ☐ C. SLUDGE
- ☐ D. OTHER ______ (Specify)
- ☐ E. SLURRY
- ☑ F. LIQUID
- ☐ G. GAS

02 WASTE QUANTITY AT SITE (Measures of waste quantities must be independent)

TONS ______

CUBIC YARDS unknown

NO. OF DRUMS ______

03 WASTE CHARACTERISTICS (Check all that apply)

- ☐ A. TOXIC
- ☐ B. CORROSIVE
- ☐ C. RADIOACTIVE
- ☐ D. PERSISTENT
- ☐ E. SOLUBLE
- ☐ F. INFECTIOUS
- ☐ G. FLAMMABLE
- ☐ H. IGNITABLE
- ☐ I. HIGHLY VOLATILE
- ☐ J. EXPLOSIVE
- ☐ K. REACTIVE
- ☐ L. INCOMPATIBLE
- ☐ M. NOT APPLICABLE

III. WASTE TYPE

CATEGORY	SUBSTANCE NAME	01 GROSS AMOUNT	02 UNIT OF MEASURE	03 COMMENTS
SLU	SLUDGE			
OLW	OILY WASTE	unknown		
SOL	SOLVENTS			
PSD	PESTICIDES			
OCC	OTHER ORGANIC CHEMICALS			
IOC	INORGANIC CHEMICALS			
ACD	ACIDS			
BAS	BASES			
MES	HEAVY METALS			

IV. HAZARDOUS SUBSTANCES (See Appendix for most frequently cited CAS Numbers)

01 CATEGORY	02 SUBSTANCE NAME	03 CAS NUMBER	04 STORAGE/DISPOSAL METHOD	05 CONCENTRATION	06 MEASURE OF CONCENTRATION
	unknown			--	

V. FEEDSTOCKS (See Appendix for CAS Numbers)

CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER	CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER
FDS			FDS		
FDS			FDS		
FDS			FDS		
FDS			FDS		

VI. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

KDWM Files

EPA

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION
01 STATE: KY | 02 SITE NUMBER: New Site

II. HAZARDOUS CONDITIONS AND INCIDENTS

01 ☑ A. GROUNDWATER CONTAMINATION — 02 ☑ OBSERVED (DATE: 08-21-87) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: 217 — 04 NARRATIVE DESCRIPTION

217 people reside within a 3 mile radius of site using groundwater for drinking

01 ☑ B. SURFACE WATER CONTAMINATION — 02 ☑ OBSERVED (DATE: 04-03-1973) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: 28,795 — 04 NARRATIVE DESCRIPTION

Estimated pop. for 1987. Population in 1973 was considerably less.

01 ☐ C. CONTAMINATION OF AIR — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ — 04 NARRATIVE DESCRIPTION

unknown

01 ☐ D. FIRE/EXPLOSIVE CONDITIONS — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ — 04 NARRATIVE DESCRIPTION

none

--

01 ☑ E. DIRECT CONTACT — 02 ☑ OBSERVED (DATE: 08-21-87) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: 28,795 — 04 NARRATIVE DESCRIPTION

Population within a four (4) mile radius of the site.

01 ☐ F. CONTAMINATION OF SOIL — 02 ☐ OBSERVED (DATE: ______) ☑ POTENTIAL ☐ ALLEGED
03 AREA POTENTIALLY AFFECTED: 3 1/2 (acres) — 04 NARRATIVE DESCRIPTION

Appr. size of pond that was filled with garbage.

01 ☑ G. DRINKING WATER CONTAMINATION — 02 ☐ OBSERVED (DATE: ______) ☑ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: 301 — 04 NARRATIVE DESCRIPTION

301 people utilize wells as a source of potable water within a 4 mile radius. 217 utilize wells with a three (3) mile radius.

01 ☐ H. WORKER EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 WORKERS POTENTIALLY AFFECTED: ______ — 04 NARRATIVE DESCRIPTION

None

01 ☑ I. POPULATION EXPOSURE/INJURY — 02 ☑ OBSERVED (DATE: 08-21-87) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: 28,795 — 04 NARRATIVE DESCRIPTION

Population within a four (4) mile radius.

EPA

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER
KY	New Site

II. HAZARDOUS CONDITIONS AND INCIDENTS (Continued)

01 ☑ J. DAMAGE TO FLORA — 02 ☑ OBSERVED (DATE: 08-24-97) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

None observed

01 ☐ K. DAMAGE TO FAUNA — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION (Include name(s) of species)

unknown

01 ☐ L. CONTAMINATION OF FOOD CHAIN — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

unknown

01 ☐ M. UNSTABLE CONTAINMENT OF WASTES (Spills/runoff/standing liquids/leaking drums) — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ 04 NARRATIVE DESCRIPTION

unknown

01 ☐ N. DAMAGE TO OFFSITE PROPERTY — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

none observed

01 ☐ O. CONTAMINATION OF SEWERS, STORM DRAINS, WWTPs — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

none observed

01 ☐ P. ILLEGAL/UNAUTHORIZED DUMPING — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

A pond behind the ice company was filled with garbage beginning in 1973 until 1988.

05 DESCRIPTION OF ANY OTHER KNOWN, POTENTIAL, OR ALLEGED HAZARDS

unknown

III. TOTAL POPULATION POTENTIALLY AFFECTED: ______

IV. COMMENTS

V. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

KYDWM Files

EPA FORM 2070-12 (7-81)

11-25-86 DI

CRITICAL HRS FACTOR DOCUMENTATION FORM DATE: 8-21-87

:TE NAME: Richmond Ice Company

'A ID #: New Site REVIEWER: Jon Maybrier

.) Is an observed release documented (background and site samples are available and the site is shown to be the source of the contamination) or is one likely?

GROUNDWATER: Yes __ No ✓ Likely __ SURFACE WATER: Yes __ No ✓ Likely __
Groundwater info source: KY DWM Files
Surface water info source: " " "

2) What is the depth at the site to the shallowest aquifer used locally for drinking water?

Depth: 30' to 35' Known __ Estimated ✓ Unknown __
Source: USGS, 1960 - Availability of Ground Water in Clark, Estill, Madison, and Powell Counties

3) What is the distance to surface water from the hazardous waste?

Distance: < 500' Known ✓ Estimated __ Unknown __
Source: USGS, 1965 — Richmond South Quadrangle 7.5 Minute Series Topo Map

4) What are the most toxic/persistent chemicals at the site: Unknown __

a) Toluene b) __ c) __
Source: KYDWM Files

5) What is the hazardous waste quantity?

Quantity: unknown Known __ Estimated __ Unknown __
Source:

6) What is the distance to the nearest public water supply well using the aquifer of concern and what is the population served?

Distance: __ Known __ Estimated __ Unknown ✓
Population: __ Known __ Estimated __ Unknown ✓
Source:

7) What is the distance to the nearest private water supply well using the aquifer of concern and what is the population served within 3 miles?

Distance: 1.1 miles Known __ Estimated ✓ Unknown __
Population: 4 people Known __ Estimated ✓ Unknown __
Source: USGS 1965 - Richmond South Quadrangle 7.5 Minute Series Topo Map

8) What is the distance to the nearest downstream surface water intake and the population served?

Distance: > 15 miles Known ✓ Estimated __ Unknown __
Population: __ Known __ Estimated __ Unknown __
Source:

REGION IV RCRA/NPL POLICY QUESTIONNAIRE FOR INITIAL SCREENING

Site Name: Richmond Ice Company

City Richmond State Ky

Facility I.D. Number New Site

Type of Facility: Generator_____ Transporter_______ TSD______

I. RCRA APPLICABILITY

	yes	no
Does the facility have RCRA interim status?	____	✓
Does the facility have a final or post-closure permit? If so, date issued________________	____	✓
Is the facility a non-notifier that has been identified by States or EPA?	____	✓
Is the facility a known or possible protective filer?	____	✓
Have RCRA wastes been stored onsite for longer than 90 days since November 19, 1980?	____	✓
Have RCRA wastes been disposed onsite since November 19, 1980?	____	✓

STOP HERE IF ALL ANSWERS TO QUESTIONS IN SECTION I ARE NO

II. FINANCIAL STATUS

	yes	no
Is the facility owned by an entity that has filed for bankruptcy under federal laws (Chapter 7 or 11) or State laws?	____	____

If yes, what has it filed under?

Chapter 7_____ Chapter 11 ______ Other _______

III. ENFORCEMENT

RCRA Status	yes	no
Has the facility lost authorization to operate via LOIS, 3005(e) permit denial, 3008(h) IS termination, 3005(d) permit revocation?	______	______
Has the facilities interim status been terminated via another mechanism (i.e. administrative termination)?	______	______

IV. CERCLA STATUS

What CERCLA financed remedial or removal activities have been initiated at the site? (RI/FS, RD/RA, O&M, forward planning, and removal; does not include enforcement or PA/SI activities).

V. Enforcement Status

	yes	no
In general, would you characterize the facility as demonstrating an unwillingness to undertake corrective action based on prior State, CERCLA or RCRA actions?	______	______

If yes, please describe and cite the authorities exercised.

	yes	no
Is the owner/operator a party to any enforcement action at the site?	______	______

If not, why not?

Are any PRPs (including owner/operators) undertaking remedial studies or action in response to CERCLA enforcement authorities? What is the extent/type of work that has been completed (RI/FS, etc.) and who (generators, owner/operator, etc.) is conducting the work?

DRAFT
11-25-86

SITE SCREENING SUMMARY

Site Name: Richmond Ice Company

EPA ID #: New Site

Reviewer Name: Jan Maybriar   Date: 08-21-87

I. **INITIAL REVIEW:** (Check where appropriate)

NPL ___ RCRA ___ Fed. Fac. ___ "Low Priority" Landfill ___

NFA ___ reason: ___

II. **LEAD:** Fund ___ Enforcement ✓ Unknown ___

III. **REMOVAL:** Needed ___ reason: ___

Completed ___ (score using preremoval conditions)

IV. **HRS SCORE:** 18.55 observed release / 4.44 No observed Release   Confidence: high ___ medium ___ low ✓

V. **LOCATION:** Latitude: 37°44'26".2   Longitude: 84°16'03".5

V. **INFORMATION NEEDED:** (Check information needed to determine disposition)

A. **Preliminary Assessment**   (Notes/sources for future reference)

___	1. RCRA Status Information	
✓	2. Observed Release	Oil slick note near waters edge April 3,1978
___	3. Target Information	
✓	4. Distance to Surface Water	< 500' to intermittent stream
✓	5. Depth to aquifer of concern	30' to 35'
✓	6. Waste identity	Oil
✓	7. Hazardous waste quantity	unknown
___	8. Others (list)	

B. **Site Investigation**

___	1. Waste identity	
___	2. Distance to surface water	
✓	3. Slope/intervening terrain	0-2%
___	4. Containment	
___	5. Observed release (surface)	
___	6. Observed release (ground)	
___	7. Hazardous waste quantity	
___	8. Others (list)	

SITE DISCOVERY FORM

Part 1: Information necessary to add a site to CERCLIS

ACTION: A

EPA ID: ___________

SITE NAME: Richmond Ice Plant SOURCE: _ (R=EPA, T=STATE)

STREET: Big Hill Avenue and Heath CONG DIST: 05 (optional)

CITY: Richmond ZIP: 40475 - ____

CNTY NAME: Madison CNTY CODE: 151 (optional)

LATITUDE: 37° 44' / 26" LONGITUDE: 84° / ~~17~~ 16' / ~~45~~ 05" (optional)

INVENTORY IND: Y REMEDIAL IND: Y REMOVAL IND: N FED FAC IND: N

RPM NAME: ___________________ RPM PHONE: ___ - ___ - ____ (EPA Project Officer

SITE DESCRIPTION: (optional)

Off Big Hill Avenue behind Richmond Ice Plant

Part 2: Other site information

DATE SITE FIRST REPORTED: __ / __ / __ REPORTED BY: ____________________

REASON FOR LISTING:

Questionable fill for small lake-Inspector observed oil slick and oil on banks-
other slimy substances dumped in lake.

B

DRAFT
11-25-86

HRS SCORE SHEET DATE: 8-21-87

SITE NAME: Richmond Ice Company

EPA ID #: New Site REVIEWER: Jon Maybr

HRS FACTOR SCORES

	Score	Default	Known	Estimate
1) Toxicity/persistence (TP)	9	none		
2) Waste quantity (WQ)	1	(1)		
3) Containment (Groundwater) (C_{gw})	3	(3)		
4) Depth to aquifer of concern (D_{ac})	4	(6)		
5) Distance to nearest well/population (DP_g)	6	none		
6) Containment (Surface Water) (C_{sw})	3	(3)		
7) Distance to surface water (D_{sw})	3	(6)		
8) Distance to surface intake/population (DP_s)	0	none		

S GROUNDWATER ROUTE SCORING:

a) If observed release: $S_{gw} = \frac{(TP + WQ)(DP_g + 9)}{12.74}$ $\frac{(10)(15)}{12.74}$ = 11.77

) If no observed release: $S_{gw} = \frac{(D_{ac} + 7)(TP + WQ)(DP_g + 9)(C_{gw})}{573.3}$ = 8.63

$\frac{(11)(10)(15)(3)}{573.3}$

SURFACE WATER ROUTE SCORING

If observed release: $S_{sw} = \frac{(TP + WQ)(DP_s + 9)}{14.3}$ $\frac{(10)(9)}{14.3}$ = 6.29

If no observed release: $S_{sw} = \frac{(D_{sw} + 5)(TP + WQ)(DP_s + 9)(C_{sw})}{643.5}$ = 3.36

$\frac{(8)(10)(9)(3)}{643.5}$

MULTIMEDIA HRS SCORING

Do not score the air route unless an observed release is known to have occurred.

$$S_m = \sqrt{\frac{S_{gw}^2 + S_{sw}^2}{1.73}} =$$

7.7 observed release
5.4 no observed release

The scoring in above steps is based on the following default scores:

1) the sum of the scores for net precipitation, permeability, and physical state is 7,
2) the groundwater use is for drinking and the score used is 9.
3) the sum of the scores for slope/terrain, rainfall and physical state is 5,
4) the sum of the scores for surface water use and distance to sensitive environments is 9.

If these assumptions are known to be substantially incorrect, complete an HRS scoring sheet.

Facility Name: Richmond Ice Company

Location: Richmond, Ky. 816 Heath Street

EPA Region: IV

Person(s) in Charge of the Facility: Marsh Orwtenburger

Marylin Williams

Name of Reviewer: J. Maybrier Date: 08-21-87

General Description of the Facility:

(For example: landfill, surface impoundment, pile, container; types of hazardous substances; location of the facility; contamination route of major concern; types of information needed for rating; agency action, etc.)

• A pond behind the Richmond Ice Company was filled in with garbage beginning in '73 until '78. Oil was noted on edge of pond on a April 3, 1973 site visit. In May 1978 the pond and garbage was graded and covered with soil.

Scores: $S_M = \frac{7.77}{5.77}$ ($S_{gw} = \frac{9.42}{6.91}$ $S_{sw} = \frac{4.20}{3.36}$ $S_a = \frac{29.49}{0.0}$) $\frac{\text{observed Release}}{\text{No Observed Release}}$

S_{FE} = NOT SCORED

S_{DC} = 41.67 observed release

. Figure 1

HRS COVER SHEET

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)	
1 Observed Release	0 45	1		45	3.1	
If observed release is given a score of 45, proceed to line 4. If observed release is given a score of 0, proceed to line 2.						
2 Route Characteristics					3.2	
Depth to Aquifer of Concern	0 1 2 3	2	4	6		30' to 35'
Net Precipitation	0 1 2 3	1	2	3		47 normal annual - 35 seasonal evaporation 12 inches
Permeability of the Unsaturated Zone	0 1 ~~2~~ 3	1	3/~~2~~	3		
Physical State	0 1 2 3	1	3	3		liquid oil
Total Route Characteristics Score			11	15		
3 Containment	0 1 2 3	1	3	3	3.3	poured directly on the ground
4 Waste Characteristics					3.4	
Toxicity/Persistence	0 3 6 9 12 15 18	1	9 | 9	18		2/1
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	1 | 1	8		< 40 drums
Total Waste Characteristics Score			10 | 10	26		
5 Targets					3.5	
Ground Water Use	0 1 ~~2~~ 3	3	9 ~~6~~ | ~~6~~ 9	9		
Distance to Nearest Well/Population Served	0 4 ~~6~~ 8 10 12 16 18 20 24 30 32 35 40	1	6 | 6	40		1.1 miles / 4 people
Total Targets Score			12 | 1-	49		
6 If line 1 is 45, multiply 1 x 4 x 5			5400			
If line 1 is 0, multiply 2 x 3 x 4 x 5			3960	57,330		
7 Divide line 6 by 57,330 and multiply by 100			Sgw = 9.42 Observed Release			
			Sgw = 6.91 No Observed Release			

FIGURE 2
GROUND WATER ROUTE WORK SHEET

DRAFT

Surface Water Route Work Sheet						
Rating Factor	Assigned Value (Circle One)	Multiplier	Score		Max. Score	Ref. (Section)
1 Observed Release	0 45	1			45	4.1
If observed release is given a value of 45, proceed to line 4. If observed release is given a value of 0, proceed to line 2.						
2 Route Characteristics						4.2
Facility Slope and Intervening Terrain	0 1 2 3	1	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1	2		3	
Distance to Nearest Surface Water	0 1 2 3	2	6		6	
Physical State	0 1 2 3	1	3		3	
Total Route Characteristics Score			12		15	
3 Containment	0 1 2 3	1	3		3	4.3
4 Waste Characteristics						4.4
Toxicity/Persistence	0 3 6 9 12 15 18	1	9	9	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	1	1	8	
Total Waste Characteristics Score			10	10	26	
5 Targets						4.5
Surface Water Use	0 1 2 3	3	6	6	9	
Distance to a Sensitive Environment	0 1 2 3	2	0	0	6	
Population Served/Distance to Water Intake Downstream	0 4 6 8 10 / 12 16 18 20 / 24 30 32 35 40	1	0	0	40	
Total Targets Score			6	6	55	
6 If line 1 is 45, multiply 1 x 4 x 5			2700			
If line 1 is 0, multiply 2 x 3 x 4 x 5			2160		64,350	
7 Divide line 6 by 64,350 and multiply by 100			S_{sw} = 4.20 Observed Release			
			S_{sw}=3.36 No Observed Release			

< 3 %

2.75 "

< 500' to intermittent stream

liq. form

oil poured directly on the ground

2/1

< 40 drums

FIGURE 7
SURFACE WATER ROUTE WORK SHEET

DRAFT

Air Route Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	45	45	5.1
Date and Location:					
Sampling Protocol:					
If line 1 is 0, the S_a = 0. Enter on line 5. If line 1 is 45, then proceed to line 2.					
2 Waste Characteristics					5.2
Reactivity and Incompatibility	0 1 2 3	1	3	3	
Toxicity	0 1 2 3	3	6	9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	1	8	
	Total Waste Characteristics Score		10	20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1	21	30	
Distance to Sensitive Environment	0 1 2 3	2	0	6	
Land Use	0 1 2 3	1	2	3	
	Total Targets Score		23	39	
4 Multiply 1 x 2 x 3			2949	35,100	
5 Divide line 4 by 35,100 and multiply by 100			S_a = 29.49		

Incompatibility toluene

2

FIGURE 9
AIR ROUTE WORK SHEET

	S: Observed Release	S: No Observed Release	S^2: Observed Release	S^2: No Observed Release	
Groundwater Route Score (S_{gw})	9.42	6.91	88.74	47.75	
Surface Water Route Score (S_{sw})	4.20	3.36	17.64	11.28	
Air Route Score (S_a)	29.49	0.0	869.64	0.0	
$S_{gw}^2 + S_{sw}^2 + S_a^2$			976.04	59.03	106.38
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$			31.24	7.68	10.31
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} \,/\, 1.73$			Observed Release: S_M = 18.05		
			No Observed Release: S_M = 4.44		5.96

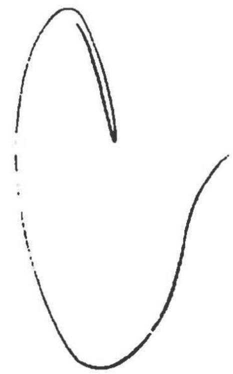
Figure 10

WORKSHEET FOR COMPUTING S_M

Direct Contact Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Incident	0 45	1		45	8.1
If line 1 is 45, proceed to line 4 If line 1 is 0, proceed to line 2					
2 Accessibility	0 1 2 3	1	3	3	8.2
3 Containment	0 15	1	15	15	8.3
4 Waste Characteristics Toxicity	0 1 2 3	5	10 | 10	15	8.4
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 4 5	4	20 | 20	20	
Distance to a Critical Habitat	0 1 2 3	4	0 | 0	12	
Total Targets Score			20 | 20	32	
6 If line 1 is 45, multiply 1 x 4 x 5 If line 1 is 0, multiply 2 x 3 x 4 x 5			9000 9000	21,600	
7 Divide line 6 by 21,600 and multiply by 100			S_{DC} = 41.67 Observed Incident		
			S_{DC} = 41.67 No Observed Incident		

21,907 people residing within a 1 mile radius of the site

FIGURE 12
DIRECT CONTACT WORK SHEET



1986 EDITION

GENERAL HIGHWAY MAP

MADISON COUNTY

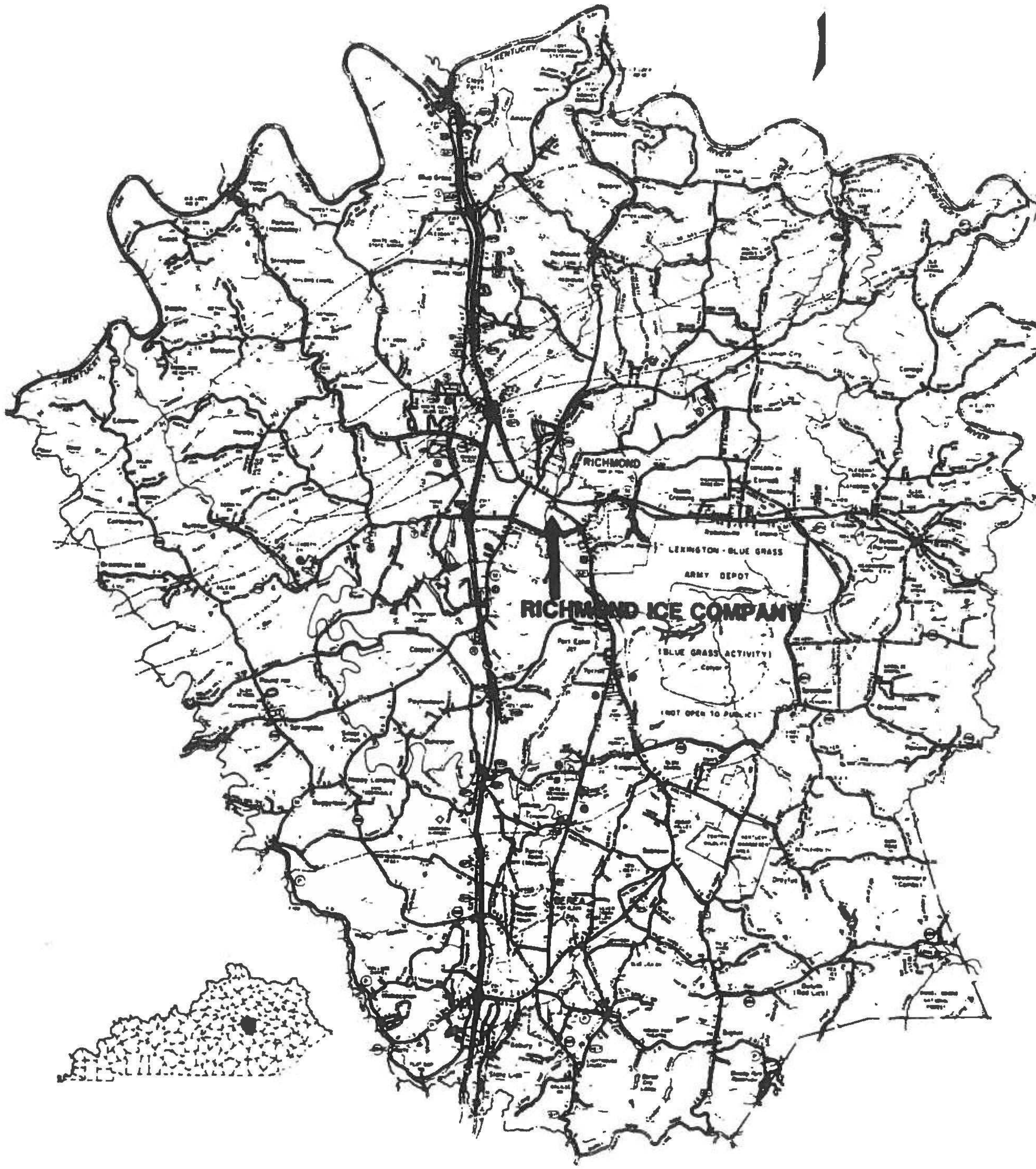
KENTUCKY

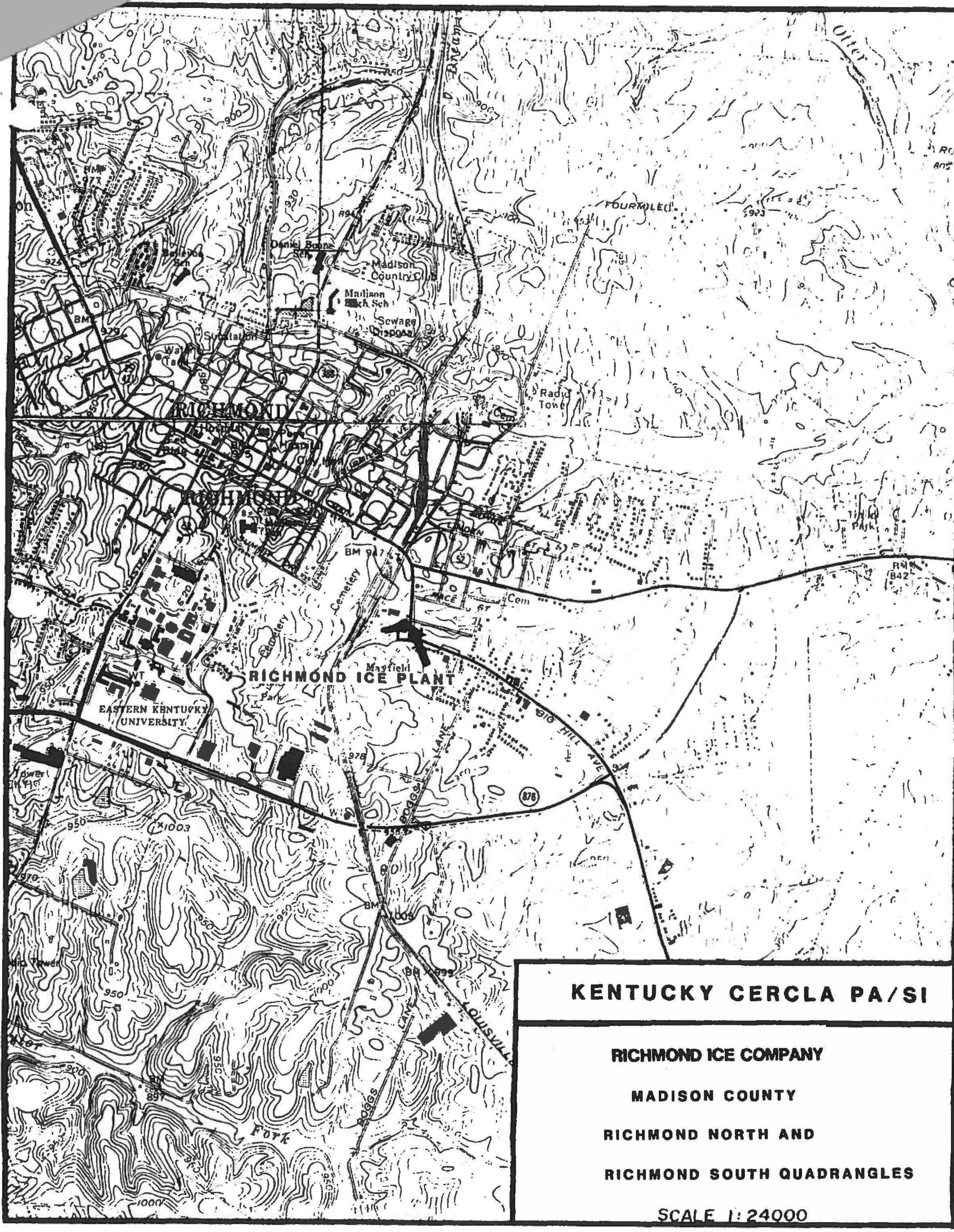
PREPARED BY THE

KENTUCKY TRANSPORTATION CABINET
DEPARTMENT OF HIGHWAYS
DIVISION OF PLANNING

IN COOPERATION WITH THE

U S DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION





KENTUCKY CERCLA PA/SI

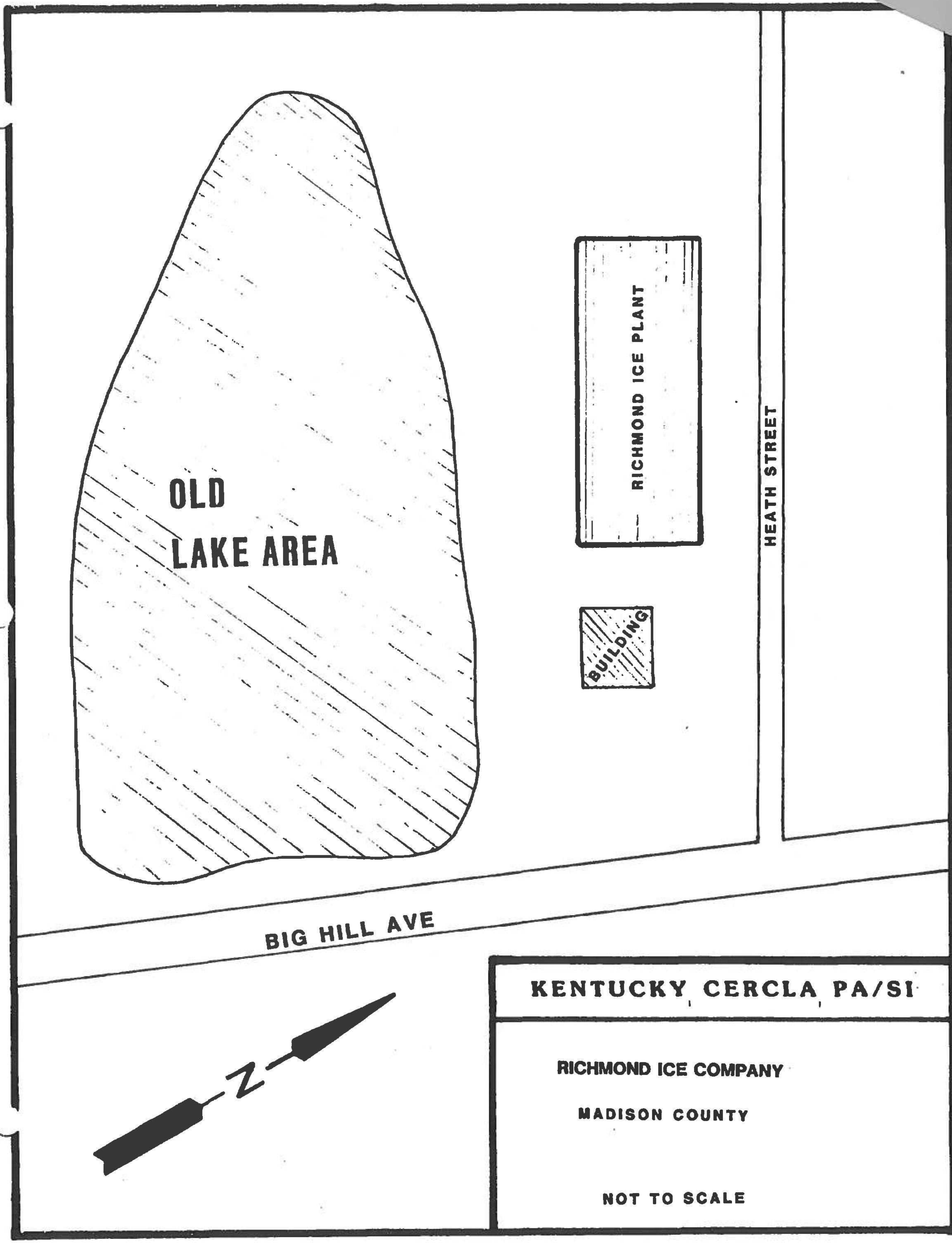
RICHMOND ICE COMPANY

MADISON COUNTY

RICHMOND NORTH AND

RICHMOND SOUTH QUADRANGLES

SCALE 1:24000


OLD
LAKE AREA
RICHMOND ICE PLANT
BUILDING
HEATH STREET
BIG HILL AVE
N
KENTUCKY CERCLA PA/SI
RICHMOND ICE COMPANY
MADISON COUNTY
NOT TO SCALE

M E M O R A N D U M

April 4, 1973

4.P

TO: Jerry Hurst, Director
Field Program
Division of Solid Waste

FROM: Theodore F. Gibson, P. H. Rep. II.
Training Program
Division of Solid Waste

SUBJECT: Investigation of Complaint at Richmond Ice Plant

On April 3, 1973, Mr. Larry Campbell, Madison County Sanitarian, and I went to the Richmond Ice Plant to investigate a report that pollutants were being dumped into a small lake in an effort to fill it.

This is definitely the case. Part of the lake's bank was black where the oil had settled and there was a small oil slick near the bank. Part of the bank was still wet from some sort of slimy substance that had been dumped into the water.

We spoke to Mr. Ben Robinson, owner of the Richmond Ice Plant, and he stated that dirt and broken up concrete were being placed in the lake with his permission, but the oil and other refuse was not.

This lake appears to be fed by a small stream and I do not see how it can be filled completely. Mr. Robinson spoke of installing some piping to allow the stream to flow, but he seemed insistent that the filling operation would continue.

I recommend that if this lake is to be filled, only dirt be used, and use of all other materials be stopped.

Theodore F. Gibson, P.H. Rep. II.
Training Program

TFG:lw

cc: Mr. Ben Robinson
c/o Richmond Ice Plant

Madison County Health Dept.

Water Pollution

MEMORANDUM

May 10, 1978

TO: Ross Singleton, Area Supervisor

FROM: Marsha Denton, PHR II md

SUBJECT: Madison County #076.01D, Richmond Ice Company

On April 25, 1978, Lloyd Funkhouser and I inspected the above named dump in Richmond, Kentucky. It is located behind the Richmond Ice Company at Big Hill and Heath Streets.

The dump had been graded recently and covered. But the perimeters of the dump need a lot of work. Also new dumping had begun at the front of the dump.

We talked to Mr. Ben Robinson, the owner. He said he had been filling in for six years, that the dump used to be a pond from which the company got the ice they sold. I told him he was in violation of the law and gave him a permit application.

MD:mg

cc: Jim Denton
Madison County Health Dept.

Eugene F. Mooney
XXXXXXXXXXXXXX
SECRETARY

JULIAN M. CARROLL
GOVERNOR

COMMONWEALTH OF KENTUCKY
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
BUREAU OF ENVIRONMENTAL PROTECTION
JOHN A. ROTH
COMMISSIONER
FRANKFORT, KENTUCKY 40601

May 9, 1978

Mr. Ben Robinson
Richmond Ice Company
Heath Street
Richmond, Kentucky 40475

Dear Mr. Robinson:

On April 25, 1978, field staff from our division inspected a tract of land belonging to the Richmond Ice Company located in Richmond at Big Hill Avenue and Heath Street behind the ice company. This land is being used for disposal of construction debris, junk and household waste and appears to be in violation of the Kentucky Solid Waste Regulations.

This problem can be alleviated by either removing said waste and depositing it in a state approved landfill or by covering the waste with a minimum of two feet of soil to prevent its recurrence.

I would appreciate a written reply from you stating your intentions and a time schedule for correcting this apparent violation. Your reply should be received in this office no later than May 24, 1978. If you have any questions concerning this matter, or if this office may be of assistance, please feel free to contact me.

Sincerely,

Caroline Patrick Haight

Caroline Patrick Haight, Chief
Non-Hazardous Waste Management Section
Division of Hazardous Material & Waste Management

CPH:MD:mg

cc: Ross Singleton, Area Supervisor
Marsha Denton, Inspector

April 18, 1973

Richmond Ice Plant
Richmond,
Kentucky 40475

Attention: Ben Robinson

Dear Sir:

It has been brought to the attention of this office that solid waste is being disposed of on property belonging to the Richmond Ice Plant. It is further noted that this waste is being dumped into a body of water. This letter is to inform you, as property owner, that such action is in violation of the law and must cease immediately.

Enclosed is a copy of "Kentucky Solid Waste Disposal Laws and Regulations," of which you should read K.R.S. 211.707, 211.713, 211.717 and 211.992. Furthermore, certain sections of K.R.S. 433 are also being violated. Attached is a copy of these laws.

It is highly recommended that access to this area be prohibited and that permission to dump there be withdrawn. By way of copy of this letter, I am notifying the State Police and the County Sheriff's office in an effort to stop unauthorized dumping at the site.

Notify this office in writing of your intentions and schedule of correcting these violations.

Sincerely yours,

Jerry Hurst

Jerry L. Hurst
Associate Sanitary Engineer
Field Program

JLH:mg

cc: Madison County Health Department
Madison County Sheriff
Ky. State Police, Post #7

May 23, 1973

Madison County Health Department
Route 3, Box 11A
Boggs Lane
Richmond, Kentucky 40475

ATTN: Dale Marcum

Dear Sir:

This letter is in reference to the application of the Richmond Ice Plant to fill in the lake just off of Big Hill Avenue.

In the application there was no mention as to what types of materials would be used to fill the lake. In your cover letter, you stated "If dirt only is gradually used to fill this lake, then it will eliminate the nuisance of odor and breeding of vectors." I agree with that statement, but there was no mention of "dirt only" being used to fill in the lake. I assume this was a verbal understanding between you and the Ice Plant.

If it is true that the intent to fill with dirt only then this office does not even require a permit. Dirt is not considered a form of solid waste and therefore, this operation would not be one of solid waste but in fact a grading operation.

However, I might add that from experience I have learned that any type of filling operation seems to attract garbage. Since the property owner is responsible for the condition of the land, the Richmond Ice Plant will have to control this operation in order to prevent any type of waste being disposed of at the site.

Again, I want to say that a permit from this office is not required if dirt is all that is to be used to fill the lake. If any other material is to be used, the application should be resubmitted along with a list of the types of materials to be disposed of.

If this office can be of any assistance, do not hesitate to contact us.

Sincerely,

Jerry Hurst

Jerry L. Hurst, Associate Sanitary Engineer
Field Program

JLH sw

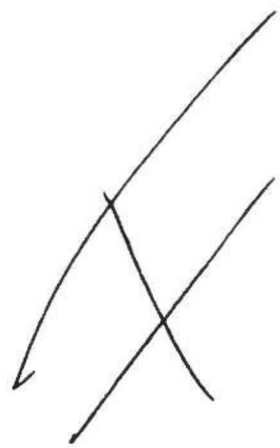
cc: Richmond Ice Company

E

UNSCANNABLE

MEDIA

(PHOTOGRAPHS)



SOURCE2

PUBLIC WATER SYSTEMS WITHDRAWING WATER FROM SURFACE SOURCES
(NOTE: AVERAGE PRODUCTION INCLUDES DEC 1985 THRU NOV 1986 DATA)

PWS ID	SYSTEM NAME:	PRIME SRCE	POPULATION	AVG PROD	DESIGN CAP	SOURCE ID	TYPE	SOURCE NAME	AVAIL	LAT	LONG
0750907	SACRAMENTO WATER WORKS	P	1,539	0	0	01	P	MUHLENBURG WD#3	P	0000000	0000000
COUNTY: MADISON											
0760030	BEREA COLLEGE WATER DEPARTMENT	S	10,098	1,382,636	3,000,000	01	S	COWHELL LAKE	P	0373245	0841437
0762058	CLAYS FERRY CAMPGROUND	G	300	680	6,000	01	G	WELL	P	0000000	0000000
0762059	COL D J WILLIAMS PISTOL RANGE	G	25	336	.	01	G	WELL	P	.	.
0762637	DEPARTMENT OF THE ARMY	S	700	131,877	720,000	01	S	LAKE VEGA	P	0000000	0000000
0760224	KINGSTON-TERRILL WATER DIST	P	4,125	0	0	01	P	RICHMOND CITY	P	0000000	0000000
0760672	KIRKSVILLE WATER ASSOC	P	1,594	0	0	01	P	RICHMOND	P	0000000	0000000
0760285	MILFORD WATER DISTRICT	P	1,782	0	0	01	P	RICHMOND CITY	P	0000000	0000000
0760370	RICHMOND WATER/GAS/SEWER WORKS	S	16,698	4,244,994	6,000,000	01	S	KENTUCKY RIVER	P	0374705	0840600
0760407	SOUTHERN MADISON WATER DIST	P	4,623	236,773	0	01	P	BEREA WTR DEPT	P	0000000	0000000
0760441	WACO WATER DISTRICT	P	4,290	0	0	01	P	RICHMOND CITY	P	0000000	0000000

POPULATION DATA DOCUMENTATION

NAME OF SITE: Richmond Ice Plant

COUNTY: Madison

RADIUS	HOUSE/BUILDING COUNT	POPULATION
¼ Mile		
½ Mile	1635	6213
1 Mile	5765	21,907
2 Miles	7395	28,101
3 Miles	7909	30,054
4 Miles	8091	30,746

MEHTODOLOGY: House and building counts are taken from U.S.G.S Topographic map(s). These numbers are then multiplied by the conversion factor of 3.8 persons per household, as suggested in EPA's Uncontrolled Hazardous Waste Site Ranking System Users Manual, to obtain populations.

REFERENCES:
U.S.GS 1952, Photorevised 1979, Moberly Quadrangle 7.5 Minute Series Top. Map
USGS 1965 " 1979, Richmond South Quadrangle " " " "
USGS 1965, " 1979, Richmond North Quadrangle " " " "
USGS 1952, " 1979, Union City Quadrangle " " " "

COMMENTS:

POPULATION DATA DOCUMENTATION for Groundwater usage

NAME OF SITE: Richmond Ice Plant

COUNTY: Madison

RADIUS	HOUSE/BUILDING COUNT	POPULATION
¼ Mile		
½ Mile	0	0
1 Mile	0	0
2 Miles	13	50
3 Miles	57	217
4 Miles	79	301

MEHTODOLOGY: House and building counts are taken from U.S.G.S Topographic map(s). These numbers are then multiplied by the conversion factor of 3.8 persons per household, as suggested in EPA's Uncontrolled Hazardous Waste Site Ranking System Users Manual, to obtain populations.

REFERENCES:
USGS 1952, Photorevised 1979, Moberly Quad, 7.5 minute Topo Map
USGS 1965, " 1979, Richmond North, " "
USGS 1965, " 1979, Richmond South, " " "
USGS 1952, " 1979, Union City Quad, " " "

COMMENTS:

SITE DISCOVERY FORM

Part 1: Information necessary to add a site to CERCLIS

ACTION: A

EPA ID: KYD Ø42943217

SITE NAME: Richmond Ice Plant SOURCE: _ (R=EPA, T=STATE)

STREET: Big Hill Avenue and Heath CONG DIST: 05 (optional)

CITY: Richmond ZIP: 40475 - ____

CNTY NAME: Madison CNTY CODE: 151 (optional)

LATITUDE: 37° 44' / 26" LONGITUDE: 84° / 17' / 45" (optional)

INVENTORY IND: Y REMEDIAL IND: Y REMOVAL IND: N FED FAC IND: N

RPM NAME: ____ RPM PHONE: ___ - ___ - ____ (EPA Project Officer

SITE DESCRIPTION: (optional) POBOX 266

Off Big Hill Avenue behind Richmond Ice Plant

Part 2: Other site information

DATE SITE FIRST REPORTED: __ / __ / __ REPORTED BY: ____

REASON FOR LISTING:

Questionable fill for small lake-Inspector observed oil slick and oil on banks-

other slimy substances dumped in lake.

SITE DISCOVERY FORM

Part 1: Information necessary to add a site to CERCLIS

ACTION: A

EPA ID: ____________

SITE NAME: Richmond Ice Plant SOURCE: _ (R=EPA, T=STATE)

STREET: Big Hill Avenue and Heath CONG DIST: 05 (optional)

CITY: Richmond ZIP: 40475 - ____

CNTY NAME: Madison CNTY CODE: 151 (optional)

LATITUDE: 37° / 44' / 26" LONGITUDE: 84° / 17' / 45" (optional)

INVENTORY IND: Y REMEDIAL IND: Y REMOVAL IND: N FED FAC IND: N

RPM NAME: ____________________ RPM PHONE: ___ - ___ - ____ (EPA Project Officer

SITE DESCRIPTION: (optional)

Off Big Hill Avenue behind Richmond Ice Plant

Part 2: Other site information

DATE SITE FIRST REPORTED: __ / __ / __ REPORTED BY: ____________________

REASON FOR LISTING: ____________________

Questionable fill for small lake-Inspector observed oil slick and oil on banks-

other slimy substances dumped in lake.

Reference 5

Hello Mr. Turner,

From my online research of the Richmond Ice Company and Cold Storage business, it seems that the company was first organized in 1905 and was dissolved in November 2001.

I found references to ammonia being a key ingredient in making ice.

The following are the sources that I found to document my conclusions.

Richmond Ice Company organized 1905.
Original article in Richmond Register 1971
http://madisonsheritage.omeka.net/items/show/824

1907 Sanborn map showing location of Richmond Ice Company
See email with attached pdf of map

Lewis Weisenburgh buys Richmond Ice Company 1908
See email with attached pdf of his obituary

Want ad for Richmond Ice Co 1911
Shows that Richmond Ice Company was a "40 ton York compression plant"
See email with attached pdf for want ad

Ad for York Manufacturing Company Ammonia Valves, 1913
See email with attached pdf for

Popular Science article discusses use of Ammonia or Sulphurous Oxide in making ice. 1891
https://en.wikisource.org/wiki/Popular_Science_Monthly/Volume_39/May_1891/Ice-Making_and_Machine_Refrigeration

Kentucky Secretary of State
Information on Richmond Ice Company 1936 incorporation and July 2000 dissolution
https://app.sos.ky.gov/ftshow/(S(vistvys51xstxgxgfl5pgfuc))/default.aspx?id=0057096&ct=09&cs=99999

Finally, an article on making ice in Mississippi
http://mshistorynow.mdah.state.ms.us/articles/343/making-ice-in-mississippi

Elli Morris is a freelance photojournalist and the author of Cooling the South: The Block Ice Era, 1875-1975*. She is the great-granddaughter of the founder of Morris Ice Company, which opened in 1880 in Jackson, Mississippi.*

I thought her book might shed light on how ice was made that might be useful to you. You could try to get this book from KDLA through Inter-Library Loan since we do not own it.

Reference 6

Circular Area Profiling System (CAPS)

Version 10C Using Data from Summary File 1, 2010 Census

Ground Zero Coordinates: Latitude=37.755621 , Longitude=-84.304436
Richmond Ice Plant

Access the aggregated data as a csv file here: caps10c581228.csv

0.25-mile radius of specified point (Richmond Ice Plant)

Subject	Number	Percent
1. Total Population Trends, Etc.		
Universe: Total Population		
Total Population	**955**	
Total Population 2000	**1,030**	
Change in Population 2000-2010	**-75**	**-7.3**
Males	**421**	**44.1**
Females	**534**	**55.9**
Population Density	**4796**	
Land Area Sq. Miles	**0**	
2. Age		
Universe: Population		
Under 5 Years	**85**	**8.9**
Age 5 to 9 Years	**48**	**5.0**
10 to 14 Years	**53**	**5.5**
15 to 17 Years	**36**	**3.8**
18 to 19 Years	**23**	**2.4**
20 to 24 Years	**102**	**10.7**
25 to 34 Years	**165**	**17.3**
35 to 44 Years	**109**	**11.4**
45 to 54 Years	**112**	**11.7**
55 to 59 Years	**56**	**5.9**
Age60 to 64 Years	**45**	**4.7**
65 to 74 Years	**65**	**6.8**
75 to 84 Years	**36**	**3.8**
85 Years and Over	**20**	**2.1**
Median Age	33.5	

Subject	Number	Percent
Age 0 to 17	222	23.2
18 to 24 Years	125	13.1
25 to 44 Years	274	28.7
45 to 64 Years	213	22.3
62 Years and Over	143	15.0
65 Years and Over	121	12.7
3. Race		
Universe: Population		
One Race	**936**	**98.0**
White	860	90.1
Black or African American	52	5.4
American Indian and Alaska Native	3	0.3
Asian	0	0.0
Native Hawaiian and Other Pacific Islander	0	0.0
Some Other Race	21	2.2
Multi Race - Persons reporting more than one race	19	2.0
4. Hispanic or Latino and Race		
Universe: Hispanic or Latino Population		
Hispanic or Latino (of any race)	**58**	**6.1**
Mexican	NA	
Puerto Rican	NA	
Cuban	NA	
Other Hispanic or Latino	NA	
Not Hispanic or Latino	**897**	**93.9**
White Alone Not Hispanic	821	86.0
5. Relationship of Persons in Households		
Universe: Persons in Households		
Total Persons in Households	**955**	**100.0**
Householder	444	46.5
Spouse	125	13.1
Child	243	25.4
Own Child Under 18 Years	191	20.0
Other Relatives	51	5.3
Non Relatives	92	9.6
Non-rel Under 18	7	0.7

Subject	Number	Percent
Non-rel Over 65	2	0.2
Unmarried Partner	NA	
6. Households by Type		
Universe: Households		
Total Households	**444**	
Family Households (Families)	235	52.9
With Own Children Under 18 Years	113	25.5
Married Couple Family	125	28.2
With Own Children Under 18 Years	38	8.6
Female householder, No Husband Present	82	18.5
With Own Children Under 18 Years	57	12.8
Non Family Households	209	47.1
Unmarried Partner Households	NA	
Same-Sex Unmarried Partner HHs	NA	
Householder Living Alone	165	37.2
Householder 65 Years and Over	88	19.8
Households With Individuals Under 18 Years	132	29.7
7. Group Quarters		
Universe: Population Living in Group Quarters		
Population in Group Quarters	**0**	**0.0**
Institutionalized Population	0	0.0
Pop In Correctional Institutions	0	0.0
Pop in Nursing Homes	0	0.0
Pop in Other Institutions	0	0.0
NonInstitutionalized GQ Pop	0	0.0
College Dormitories (Includes college quarters off	0	0.0
Military Quarters	0	0.0
Other NonInstitutional GQ Pop	0	0.0
8. Housing Occupancy and Tenure		
Universe: Housing Units		
Total Housing Units	**507**	
Occupied Housing Units	444	87.6
Owner Occupied	164	36.9
Renter Occupied	280	63.1

Subject	Number	Percent
Vacant Housing Units	63	12.4
Vacant for Rent	36	7.1
Vacant for Sale	2	0.4
Vacant for Seasonal,Recreation or Occasional Use	2	0.4
Homeowner Vacancy Rate	1.20	
Rental Vacancy Rate	11.39	
Pop in Owner-occupied Units	354	37.1
Pop in Rented Units	601	62.9
Average Size of Owner-occupied Units	2.16	
Average Size of Renter-Occupied Units	2.15	

Note: Varibles showing "NA" are not available at the blocks level. Specify tracts as the units to be aggregated to get values for these items.

0.5-mile radius of specified point (Richmond Ice Plant)

Subject	Number	Percent
1. Total Population Trends, Etc.		
Universe: Total Population		
Total Population	**2,602**	
Total Population 2000	**2,813**	
Change in Population 2000-2010	**-211**	**-7.5**
Males	**1,182**	**45.4**
Females	**1,420**	**54.6**
Population Density	**3823**	
Land Area Sq. Miles	**1**	
2. Age		
Universe: Population		
Under 5 Years	**197**	**7.6**
Age 5 to 9 Years	**132**	**5.1**
10 to 14 Years	**129**	**5.0**
15 to 17 Years	**89**	**3.4**
18 to 19 Years	**69**	**2.7**
20 to 24 Years	**231**	**8.9**
25 to 34 Years	**384**	**14.8**
35 to 44 Years	**356**	**13.7**
45 to 54 Years	**331**	**12.7**

Subject	Number	Percent
55 to 59 Years	**144**	**5.5**
Age60 to 64 Years	**142**	**5.5**
65 to 74 Years	**213**	**8.2**
75 to 84 Years	**131**	**5.0**
85 Years and Over	**54**	**2.1**
Median Age	37.5	
Age 0 to 17	547	21.0
18 to 24 Years	300	11.5
25 to 44 Years	740	28.4
45 to 64 Years	617	23.7
62 Years and Over	477	18.3
65 Years and Over	398	15.3
3. Race		
Universe: Population		
One Race	**2,546**	**97.8**
White	2,396	92.1
Black or African American	109	4.2
American Indian and Alaska Native	6	0.2
Asian	4	0.2
Native Hawaiian and Other Pacific Islander	0	0.0
Some Other Race	31	1.2
Multi Race - Persons reporting more than one race	56	2.2
4. Hispanic or Latino and Race		
Universe: Hispanic or Latino Population		
Hispanic or Latino (of any race)	**89**	**3.4**
Mexican	NA	
Puerto Rican	NA	
Cuban	NA	
Other Hispanic or Latino	NA	
Not Hispanic or Latino	**2,513**	**96.6**
White Alone Not Hispanic	2,340	89.9
5. Relationship of Persons in Households		
Universe: Persons in Households		
Total Persons in Households	**2,602**	**100.0**
Householder	1,195	45.9

Subject	Number	Percent
Spouse	412	15.8
Child	638	24.5
Own Child Under 18 Years	488	18.8
Other Relatives	134	5.1
Non Relatives	223	8.6
Non-rel Under 18	13	0.5
Non-rel Over 65	6	0.2
Unmarried Partner	NA	
6. Households by Type		
Universe: Households		
Total Households	**1,195**	
Family Households (Families)	668	55.9
With Own Children Under 18 Years	283	23.7
Married Couple Family	412	34.5
With Own Children Under 18 Years	134	11.2
Female householder, No Husband Present	180	15.1
With Own Children Under 18 Years	102	8.5
Non Family Households	527	44.1
Unmarried Partner Households	NA	
Same-Sex Unmarried Partner HHs	NA	
Householder Living Alone	412	34.5
Householder 65 Years and Over	290	24.3
Households With Individuals Under 18 Years	319	26.7
7. Group Quarters		
Universe: Population Living in Group Quarters		
Population in Group Quarters	**0**	**0.0**
Institutionalized Population	0	0.0
Pop In Correctional Institutions	0	0.0
Pop in Nursing Homes	0	0.0
Pop in Other Institutions	0	0.0
NonInstitutionalized GQ Pop	0	0.0
College Dormitories (Includes college quarters off	0	0.0
Military Quarters	0	0.0
Other NonInstitutional GQ Pop	0	0.0

Subject	Number	Percent
8. Housing Occupancy and Tenure		
Universe: Housing Units		
Total Housing Units	**1,405**	
Occupied Housing Units	1,195	85.1
Owner Occupied	619	51.8
Renter Occupied	576	48.2
Vacant Housing Units	210	14.9
Vacant for Rent	110	7.8
Vacant for Sale	21	1.5
Vacant for Seasonal,Recreation or Occasional Use	9	0.6
Homeowner Vacancy Rate	3.28	
Rental Vacancy Rate	16.03	
Pop in Owner-occupied Units	1,291	49.6
Pop in Rented Units	1,311	50.4
Average Size of Owner-occupied Units	2.09	
Average Size of Renter-Occupied Units	2.28	

Note: Varibles showing "NA" are not available at the blocks level. Specify tracts as the units to be aggregated to get values for these items.

1-mile radius of specified point (Richmond Ice Plant)

Subject	Number	Percent
1. Total Population Trends, Etc.		
Universe: Total Population		
Total Population	**8,235**	
Total Population 2000	**8,579**	
Change in Population 2000-2010	**-344**	**-4.0**
Males	**3,872**	**47.0**
Females	**4,363**	**53.0**
Population Density	**2555**	
Land Area Sq. Miles	**3**	
2. Age		
Universe: Population		
Under 5 Years	**554**	**6.7**
Age 5 to 9 Years	**399**	**4.8**
10 to 14 Years	**346**	**4.2**

Subject	Number	Percent
15 to 17 Years	**200**	**2.4**
18 to 19 Years	**275**	**3.3**
20 to 24 Years	**1,233**	**15.0**
25 to 34 Years	**1,305**	**15.8**
35 to 44 Years	**941**	**11.4**
45 to 54 Years	**961**	**11.7**
55 to 59 Years	**403**	**4.9**
Age60 to 64 Years	**370**	**4.5**
65 to 74 Years	**555**	**6.7**
75 to 84 Years	**459**	**5.6**
85 Years and Over	**234**	**2.8**
Median Age	36.5	
Age 0 to 17	1,499	18.2
18 to 24 Years	1,508	18.3
25 to 44 Years	2,246	27.3
45 to 64 Years	1,734	21.1
62 Years and Over	1,467	17.8
65 Years and Over	1,248	15.2
3. Race		
Universe: Population		
One Race	**8,057**	**97.8**
White	7,346	89.2
Black or African American	509	6.2
American Indian and Alaska Native	24	0.3
Asian	77	0.9
Native Hawaiian and Other Pacific Islander	4	0.0
Some Other Race	97	1.2
Multi Race - Persons reporting more than one race	178	2.2
4. Hispanic or Latino and Race		
Universe: Hispanic or Latino Population		
Hispanic or Latino (of any race)	**222**	**2.7**
Mexican	NA	
Puerto Rican	NA	
Cuban	NA	
Other Hispanic or Latino	NA	

Subject	Number	Percent
Not Hispanic or Latino	**8,013**	**97.3**
White Alone Not Hispanic	7,219	87.7
5. Relationship of Persons in Households		
Universe: Persons in Households		
Total Persons in Households	**7,869**	**95.6**
Householder	3,840	46.6
Spouse	1,117	13.6
Child	1,746	21.2
Own Child Under 18 Years	1,346	16.3
Other Relatives	371	4.5
Non Relatives	795	9.7
Non-rel Under 18	20	0.2
Non-rel Over 65	15	0.2
Unmarried Partner	NA	
6. Households by Type		
Universe: Households		
Total Households	**3,840**	
Family Households (Families)	1,839	47.9
With Own Children Under 18 Years	811	21.1
Married Couple Family	1,117	29.1
With Own Children Under 18 Years	384	10.0
Female householder, No Husband Present	528	13.7
With Own Children Under 18 Years	318	8.3
Non Family Households	2,001	52.1
Unmarried Partner Households	NA	
Same-Sex Unmarried Partner HHs	NA	
Householder Living Alone	1,566	40.8
Householder 65 Years and Over	912	23.7
Households With Individuals Under 18 Years	895	23.3
7. Group Quarters		
Universe: Population Living in Group Quarters		
Population in Group Quarters	**366**	**4.4**
Institutionalized Population	233	2.8
Pop In Correctional Institutions	190	2.3
Pop in Nursing Homes	43	0.5

Subject	Number	Percent
Pop in Other Institutions	0	0.0
NonInstitutionalized GQ Pop	133	1.6
College Dormitories (Includes college quarters off	129	1.6
Military Quarters	0	0.0
Other NonInstitutional GQ Pop	4	0.0
8. Housing Occupancy and Tenure		
Universe: Housing Units		
Total Housing Units	**4,409**	
Occupied Housing Units	3,840	87.1
Owner Occupied	1,400	36.5
Renter Occupied	2,440	63.5
Vacant Housing Units	569	12.9
Vacant for Rent	284	6.4
Vacant for Sale	72	1.6
Vacant for Seasonal,Recreation or Occasional Use	31	0.7
Homeowner Vacancy Rate	4.89	
Rental Vacancy Rate	10.43	
Pop in Owner-occupied Units	2,979	36.2
Pop in Rented Units	4,890	59.4
Average Size of Owner-occupied Units	2.13	
Average Size of Renter-Occupied Units	2.01	

Note: Varibles showing "NA" are not available at the blocks level. Specify tracts as the units to be aggregated to get values for these items.

2-mile radius of specified point (Richmond Ice Plant)

Subject	Number	Percent
1. Total Population Trends, Etc.		
Universe: Total Population		
Total Population	**26,237**	
Total Population 2000	**24,881**	
Change in Population 2000-2010	**1,356**	**5.4**
Males	**12,453**	**47.5**
Females	**13,784**	**52.5**
Population Density	**2284**	

Subject	Number	Percent
Land Area Sq. Miles	**11**	
2. Age		
Universe: Population		
Under 5 Years	**1,484**	**5.7**
Age 5 to 9 Years	**1,180**	**4.5**
10 to 14 Years	**1,077**	**4.1**
15 to 17 Years	**609**	**2.3**
18 to 19 Years	**2,665**	**10.2**
20 to 24 Years	**5,618**	**21.4**
25 to 34 Years	**4,147**	**15.8**
35 to 44 Years	**2,597**	**9.9**
45 to 54 Years	**2,485**	**9.5**
55 to 59 Years	**990**	**3.8**
Age60 to 64 Years	**866**	**3.3**
65 to 74 Years	**1,209**	**4.6**
75 to 84 Years	**892**	**3.4**
85 Years and Over	**418**	**1.6**
Median Age	31.1	
Age 0 to 17	4,350	16.6
18 to 24 Years	8,283	31.6
25 to 44 Years	6,744	25.7
45 to 64 Years	4,341	16.5
62 Years and Over	3,006	11.5
65 Years and Over	2,519	9.6
3. Race		
Universe: Population		
One Race	**25,595**	**97.6**
White	22,674	86.4
Black or African American	2,224	8.5
American Indian and Alaska Native	72	0.3
Asian	304	1.2
Native Hawaiian and Other Pacific Islander	16	0.1
Some Other Race	305	1.2
Multi Race - Persons reporting more than one race	642	2.4
4. Hispanic or Latino and Race		

Subject	Number	Percent
Universe: Hispanic or Latino Population		
Hispanic or Latino (of any race)	**690**	**2.6**
Mexican	NA	
Puerto Rican	NA	
Cuban	NA	
Other Hispanic or Latino	NA	
Not Hispanic or Latino	**25,547**	**97.4**
White Alone Not Hispanic	22,319	85.1
5. Relationship of Persons in Households		
Universe: Persons in Households		
Total Persons in Households	**21,976**	**83.8**
Householder	10,354	39.5
Spouse	2,969	11.3
Child	4,939	18.8
Own Child Under 18 Years	3,833	14.6
Other Relatives	1,091	4.2
Non Relatives	2,623	10.0
Non-rel Under 18	99	0.4
Non-rel Over 65	34	0.1
Unmarried Partner	NA	
6. Households by Type		
Universe: Households		
Total Households	**10,354**	
Family Households (Families)	4,960	47.9
With Own Children Under 18 Years	2,315	22.4
Married Couple Family	2,969	28.7
With Own Children Under 18 Years	1,159	11.2
Female householder, No Husband Present	1,474	14.2
With Own Children Under 18 Years	879	8.5
Non Family Households	5,394	52.1
Unmarried Partner Households	NA	
Same-Sex Unmarried Partner HHs	NA	
Householder Living Alone	3,849	37.2
Householder 65 Years and Over	1,741	16.8
Households With Individuals Under 18 Years	2,590	25.0

Subject	Number	Percent
7. Group Quarters		
Universe: Population Living in Group Quarters		
Population in Group Quarters	**4,261**	**16.2**
Institutionalized Population	397	1.5
Pop In Correctional Institutions	190	0.7
Pop in Nursing Homes	207	0.8
Pop in Other Institutions	0	0.0
NonInstitutionalized GQ Pop	3,864	14.7
College Dormitories (Includes college quarters off	3,761	14.3
Military Quarters	0	0.0
Other NonInstitutional GQ Pop	103	0.4
8. Housing Occupancy and Tenure		
Universe: Housing Units		
Total Housing Units	**11,463**	
Occupied Housing Units	10,354	90.3
Owner Occupied	3,447	33.3
Renter Occupied	6,907	66.7
Vacant Housing Units	1,109	9.7
Vacant for Rent	602	5.3
Vacant for Sale	130	1.1
Vacant for Seasonal,Recreation or Occasional Use	68	0.6
Homeowner Vacancy Rate	3.63	
Rental Vacancy Rate	8.02	
Pop in Owner-occupied Units	7,925	30.2
Pop in Rented Units	14,051	53.6
Average Size of Owner-occupied Units	2.30	
Average Size of Renter-Occupied Units	2.03	

Note: Varibles showing "NA" are not available at the blocks level. Specify tracts as the units to be aggregated to get values for these items.

3-mile radius of specified point (Richmond Ice Plant)

Subject	Number	Percent
1. Total Population Trends, Etc.		
Universe: Total Population		

Subject	Number	Percent
Total Population	**33,898**	
Total Population 2000	**30,218**	
Change in Population 2000-2010	**3,680**	**12.2**
Males	**16,249**	**47.9**
Females	**17,649**	**52.1**
Population Density	**1459**	
Land Area Sq. Miles	**23**	
2. Age		
Universe: Population		
Under 5 Years	**1,987**	**5.9**
Age 5 to 9 Years	**1,639**	**4.8**
10 to 14 Years	**1,562**	**4.6**
15 to 17 Years	**887**	**2.6**
18 to 19 Years	**2,847**	**8.4**
20 to 24 Years	**6,348**	**18.7**
25 to 34 Years	**5,290**	**15.6**
35 to 44 Years	**3,629**	**10.7**
45 to 54 Years	**3,471**	**10.2**
55 to 59 Years	**1,511**	**4.5**
Age60 to 64 Years	**1,280**	**3.8**
65 to 74 Years	**1,765**	**5.2**
75 to 84 Years	**1,190**	**3.5**
85 Years and Over	**492**	**1.5**
Median Age	32.5	
Age 0 to 17	6,075	17.9
18 to 24 Years	9,195	27.1
25 to 44 Years	8,919	26.3
45 to 64 Years	6,262	18.5
62 Years and Over	4,169	12.3
65 Years and Over	3,447	10.2
3. Race		
Universe: Population		
One Race	**33,110**	**97.7**
White	29,647	87.5
Black or African American	2,574	7.6
American Indian and Alaska Native	89	0.3
Asian		

Subject	Number	Percent
	412	1.2
Native Hawaiian and Other Pacific Islander	19	0.1
Some Other Race	369	1.1
Multi Race - Persons reporting more than one race	788	2.3
4. Hispanic or Latino and Race		
Universe: Hispanic or Latino Population		
Hispanic or Latino (of any race)	**879**	**2.6**
Mexican	NA	
Puerto Rican	NA	
Cuban	NA	
Other Hispanic or Latino	NA	
Not Hispanic or Latino	**33,019**	**97.4**
White Alone Not Hispanic	29,185	86.1
5. Relationship of Persons in Households		
Universe: Persons in Households		
Total Persons in Households	**29,554**	**87.2**
Householder	13,449	39.7
Spouse	4,590	13.5
Child	6,879	20.3
Own Child Under 18 Years	5,374	15.9
Other Relatives	1,432	4.2
Non Relatives	3,204	9.5
Non-rel Under 18	134	0.4
Non-rel Over 65	47	0.1
Unmarried Partner	NA	
6. Households by Type		
Universe: Households		
Total Households	**13,449**	
Family Households (Families)	7,034	52.3
With Own Children Under 18 Years	3,224	24.0
Married Couple Family	4,590	34.1
With Own Children Under 18 Years	1,809	13.5
Female householder, No Husband Present	1,804	13.4
With Own Children Under 18 Years	1,076	8.0

Subject	Number	Percent
Non Family Households	6,415	47.7
Unmarried Partner Households	NA	
Same-Sex Unmarried Partner HHs	NA	
Householder Living Alone	4,582	34.1
Householder 65 Years and Over	2,351	17.5
Households With Individuals Under 18 Years	3,602	26.8
7. Group Quarters		
Universe: Population Living in Group Quarters		
Population in Group Quarters	**4,344**	**12.8**
Institutionalized Population	480	1.4
Pop In Correctional Institutions	264	0.8
Pop in Nursing Homes	207	0.6
Pop in Other Institutions	9	0.0
NonInstitutionalized GQ Pop	3,864	11.4
College Dormitories (Includes college quarters off	3,761	11.1
Military Quarters	0	0.0
Other NonInstitutional GQ Pop	103	0.3
8. Housing Occupancy and Tenure		
Universe: Housing Units		
Total Housing Units	**14,806**	
Occupied Housing Units	13,449	90.8
Owner Occupied	5,608	41.7
Renter Occupied	7,841	58.3
Vacant Housing Units	1,357	9.2
Vacant for Rent	702	4.7
Vacant for Sale	201	1.4
Vacant for Seasonal,Recreation or Occasional Use	87	0.6
Homeowner Vacancy Rate	3.46	
Rental Vacancy Rate	8.22	
Pop in Owner-occupied Units	13,377	39.5
Pop in Rented Units	16,177	47.7
Average Size of Owner-occupied Units	2.39	
Average Size of Renter-Occupied Units	2.06	

Note: Varibles showing "NA" are not available at the blocks level. Specify tracts as the units to be aggregated to get values for these items.

Summary of True Areas of Circles vs. That of Areas Selected to Estimate Them

(This Report Indicates How Well We Were Able to Approximate the Circular Area)

radius	Estimated	True Area	Ratio of Estimate to True Area
0.25	0.20	0.20	1.014
0.50	0.68	0.79	0.868
1.00	3.24	3.14	1.033
2.00	11.53	12.57	0.918
3.00	23.35	28.27	0.826

Auxiliary Report: Counties Contributing to Circular Areas, By Concentric Ring Areas Coordinates: (37.755621 , -84.304436)

Outer radius of Ring (or circle)=0.25

County Cd	Total Pop
Madison KY	955

Outer radius of Ring (or circle)=0.5

County Cd	Total Pop
Madison KY	1,647

Outer radius of Ring (or circle)=1

County Cd	Total Pop
Madison KY	5,633

Outer radius of Ring (or circle)=2

County Cd	Total Pop
Madison KY	18,002

Outer radius of Ring (or circle)=3

County Cd	Total Pop
Madison KY	7,661
	33,898

Use this link to download the **geocodes file** (all geographic areas used)

Access the caps10c application at **http://mcdc.missouri.edu/websas/caps10c.html**

Missouri Census Data Center

Reference 7

FEEDBACK

RICHMOND, KENTUCKY

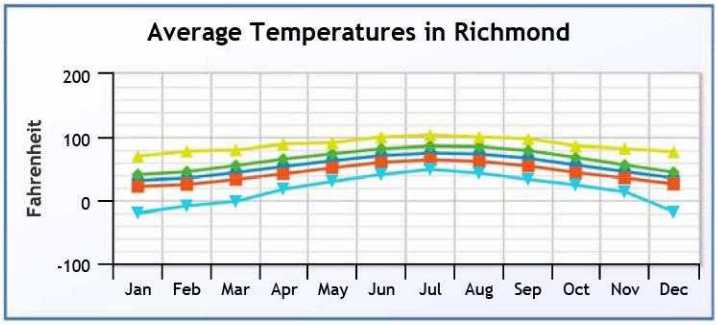
Home > North America > United States > Kentucky

Elevation: 100 feet Latitude: 37 45N Longitude: 084 20W

Köppen Classification: Humid Subtropical Climate

WEATHER

- Monthly - Summary
  - Nearby
  - Forecast
- Monthly - All Data
- Climate Summary
- Daily Averages
- Hourly Data



SHARE

PRINT THIS DATA

This climate is characterized by relatively high temperatures and evenly distributed precipitation throughout the year. This climate type is found on the eastern sides of the continents between 20° and 35° N and S latitude. In summer, these regions are largely under the influence of moist, maritime airflow from the western side of the subtropical anticyclonic cells over low-latitude ocean waters. Temperatures are high and can lead to warm, oppressive nights. Summers are usually somewhat wetter than winters, with much of the rainfall coming from convectional thunderstorm activity; tropical cyclones also enhance warm-season rainfall in some regions. The coldest month is usually quite mild, although frosts are not uncommon, and winter precipitation is derived primarily from frontal cyclones along the polar front.

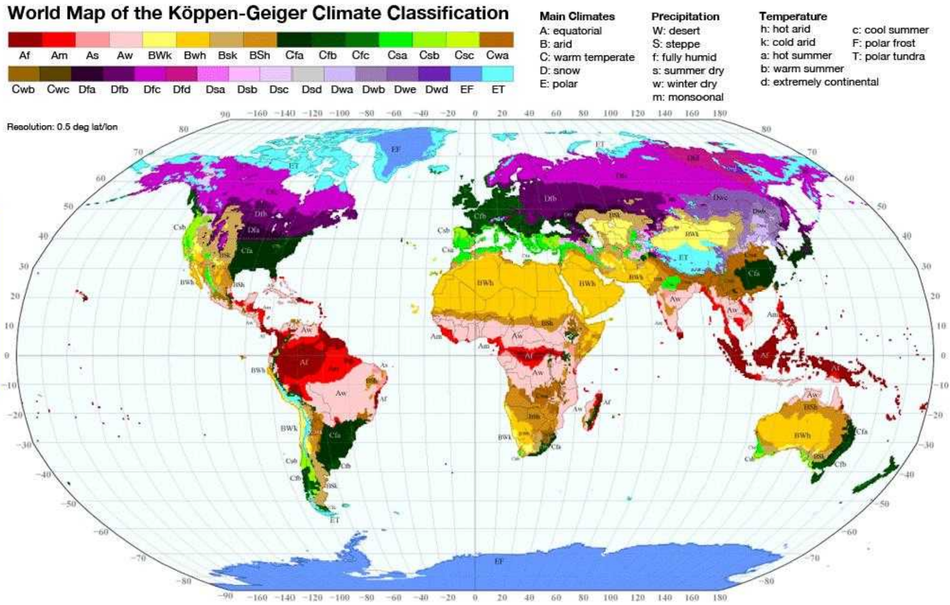
The Köppen Climate Classification subtype for this climate is "Cfa". (Humid Subtropical Climate).

The average temperature for the year in Richmond is 54.3°F (12.4°C). The warmest month, on average, is July with an average temperature of 75.0°F (23.9°C). The coolest month on average is January, with an average temperature of 31.4°F (-0.3°C).

The highest recorded temperature in Richmond is 103.0°F (39.4°C), which was recorded in July. The lowest recorded temperature in Richmond is -20.0°F (-28.9°C), which was recorded in January.

The average amount of precipitation for the year in Richmond is 46.8" (1188.7 mm). The month with the most precipitation on average is May with 5.1" (129.5 mm) of precipitation. The month with the least precipitation on average is September with an average of 3.1" (78.7 mm). There are an average of 126.5 days of precipitation, with the most precipitation occurring in May with 12.4 days and the least precipitation occurring in September with 7.6 days.

In Richmond, there's an average of 12.5" of snow (0 cm). The month with the most snow is January, with 4.5" of snow (11.4 cm).


World Map of the Köppen-Geiger Climate Classification
Af Am As Aw BWk Bwh Bsk BSh Cfa Cfb Cfc Csa Csb Csc Cwa
Cwb Cwc Dfa Dfb Dfc Dfd Dsa Dsb Dsc Dsd Dwa Dwb Dwe Dwd EF ET
Main Climates
A: equatorial
B: arid
C: warm temperate
D: snow
E: polar
Precipitation
W: desert
S: steppe
f: fully humid
s: summer dry
w: winter dry
m: monsoonal
Temperature
h: hot arid
k: cold arid
a: hot summer
b: warm summer
d: extremely continental
c: cool summer
F: polar frost
T: polar tundra
Resolution: 0.5 deg lat/lon

FEEDBACK

FEEDBACK

FEATURES
- Compare Cities
- Vacation Finder
- Weather Reference
- Weather Glossary
- Climate Calculators

ABOUT US
- About | Press
- Data Licensing
- Weather Consulting
- Contact Us
- Privacy Policy

MOBILE
- iPhone / iPad
- Google Earth
- Windows Phone

FOLLOW US
- Facebook
- Twitter

OTHER COOL SITES
- Deali.sh - Flash Sales
- Geoba.se - City Facts
- Factba.se - Country Facts
- DealChicken - Buy. Save. Yeah.
- WeatherAlpha - Big brains.

Reference 8

Record of Communication

☑ PHONE CALL	☐ DISCUSSION	☐ ON-SITE
☐ CONFERENCE	☐ OTHER	☐ ON-CALL

PARTICIPANTS: Wesley Turner

DATE: 5/24/2016

MARS D780

Site: Richmond Ice Plant

County: Madison

AI: 51865

SUMMARY OF COMMUNICATION:

Contacted the Richmond City Building Codes and Enforcement to inquire as to when the Richmond Ice Plant was demolished. Her e- records only went to 2007 so the building was demolished prior to that. Google Earth imagery from 1997 showed the building still there. I was referred to the State Department of Housing and Building Codes to conduct an open record request for the information. Sent an e-mail 5/24/2016 to Molly McCleese to request the information.

CONCLUSION, ACTION TAKEN OR REQUIRED:

INFORMATION COPIES TO:

DEP1008

OGC-01
Rev. 10/2013

PUBLIC PROTECTION CABINET
DEPARTMENT OF HOUSING, BUILDINGS AND CONSTRUCTION
REQUEST TO INSPECT PUBLIC RECORDS
PURSUANT TO KRS CHAPTER 61

Please return this form to: Department of Housing, Buildings and Construction, Attn: Records Custodian, 101 Sea Hero Road, Suite 100, Frankfort, Kentucky 40601-5412 or fax to 502-573-1057

Current Date: 5/24/2016

I hereby request to ☐ inspect or x receive copies of the following documents: (*please be specific*)

Demolition of Former Richmond Ice Plant sometime between 1997 and 2007 electronic copies preferred

PROJECT NAME & ADDRESS: 816 Heath Street, Richmond KY 40475

Are the requested documents sought for a commercial purpose? Yes ____ No _x___

If yes, please state the commercial purpose:

Submitted by: *Wesley Turner*

Please print name clearly

Wesley Turner

Signature of person requesting records

Company Name: *Kentucky Division Of Waste Management Superfund Branch*

Address: 200 Fair Oaks

Frankfort KY

Telephone: (502) 564-6716

Fax: ( )

TO BE COMPLETED BY DEPARTMENT PERSONNEL

DISPOSITION

The following disposition of the above request is recommended:

☐ Copies of records cannot be made available until approximately ______________________.

☐ The records are available for inspection and copying 8 a.m. to 4:30 p.m. Monday-Friday.

☐ The attached records are what we have, as requested.

Total number of written documents: __________ @ __________

Total number of copies of non-written records: __________ @ __________

Total cost: __________ Cash ☐ Check ☐ Money Order ☐

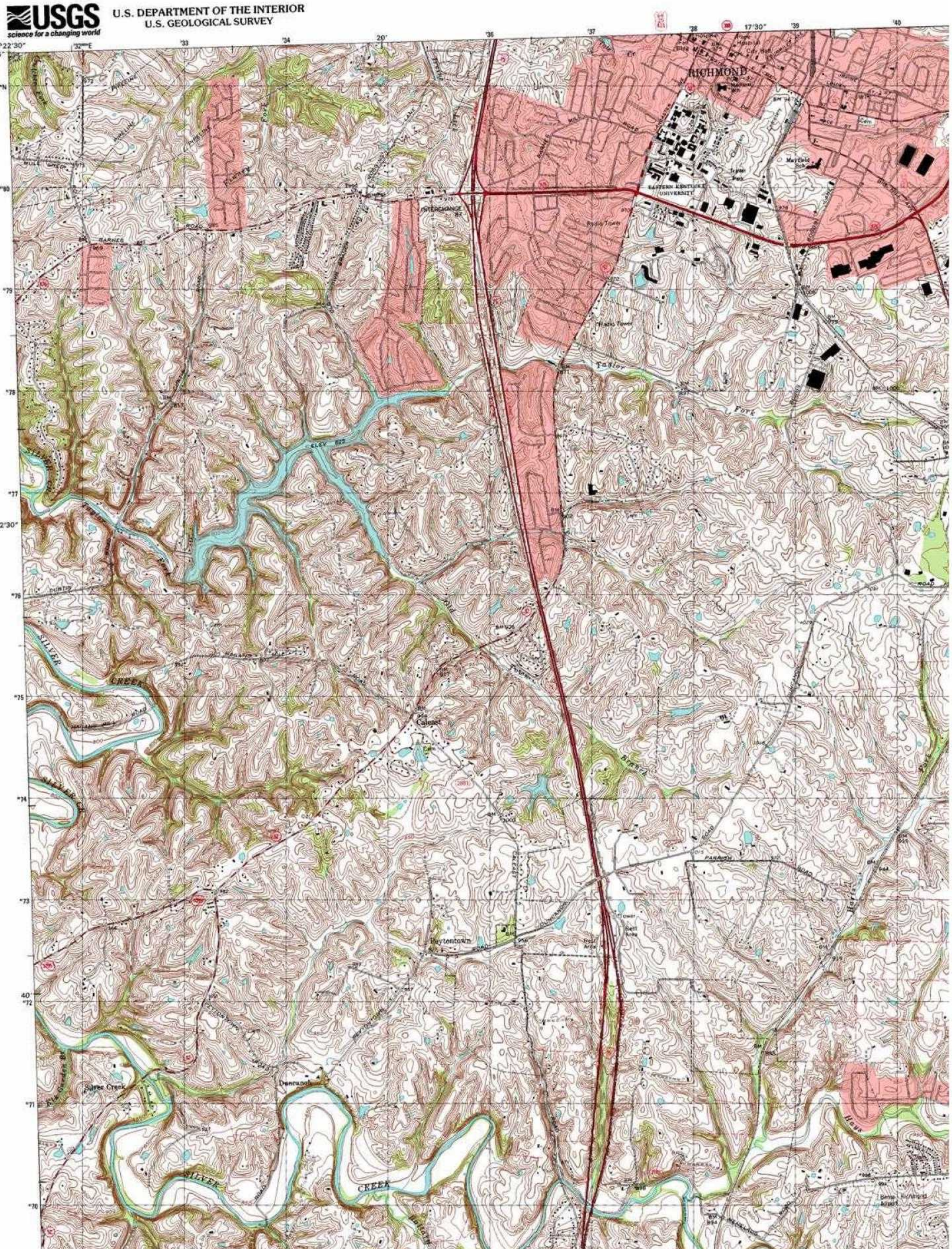
APPROVED FOR MAILING:

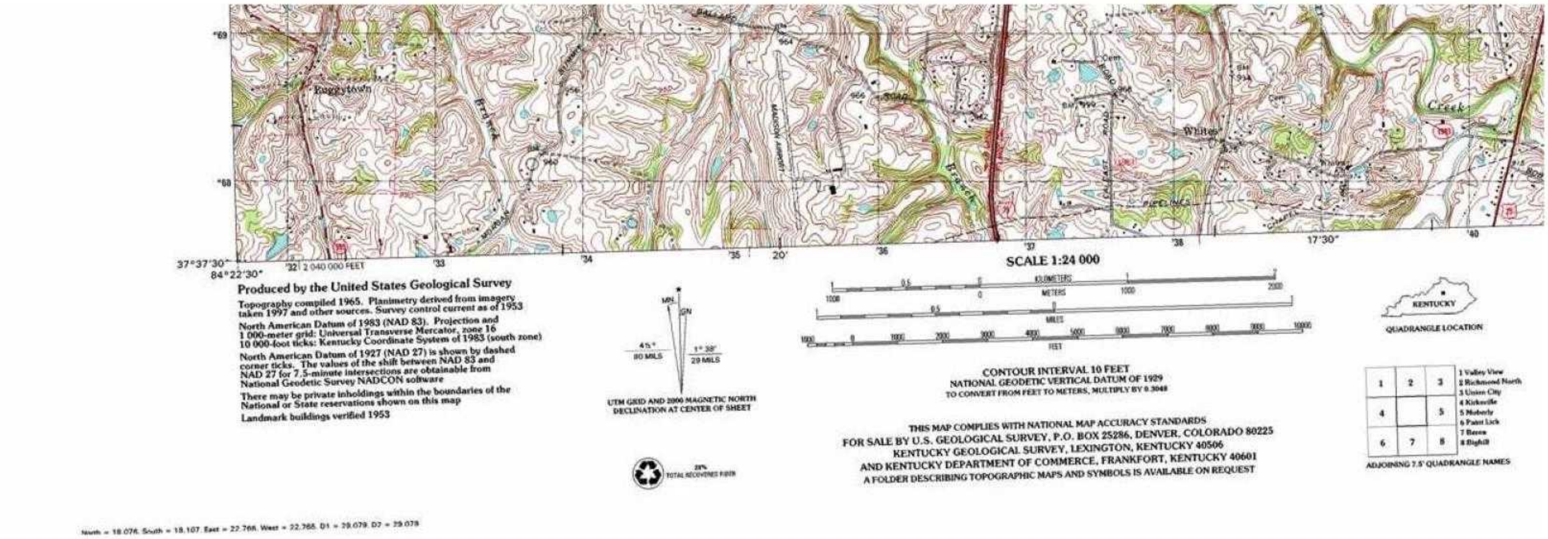
Records Custodian Date

Program Manager Date

Section/Division

Reference 9


U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
RICHMOND
EASTERN KENTUCKY UNIVERSITY
SILVER
CREEK
Peytontown
Silver Creek


Peggytown
Creek
SCALE 1:24 000
37°37'30"
84°22'30"
2 040 000 FEET
Produced by the United States Geological Survey
Topography compiled 1965. Planimetry derived from imagery taken 1997 and other sources. Survey control current as of 1953
North American Datum of 1983 (NAD 83). Projection and 1 000-meter grid: Universal Transverse Mercator, zone 16
10 000-foot ticks: Kentucky Coordinate System of 1983 (south zone)
North American Datum of 1927 (NAD 27) is shown by dashed corner ticks. The values of the shift between NAD 83 and NAD 27 for 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software
There may be private inholdings within the boundaries of the National or State reservations shown on this map
Landmark buildings verified 1953
UTM GRID AND 2000 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
KILOMETERS
METERS
MILES
FEET
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, P.O. BOX 25286, DENVER, COLORADO 80225
KENTUCKY GEOLOGICAL SURVEY, LEXINGTON, KENTUCKY 40506
AND KENTUCKY DEPARTMENT OF COMMERCE, FRANKFORT, KENTUCKY 40601
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
KENTUCKY
QUADRANGLE LOCATION
ADJOINING 7.5' QUADRANGLE NAMES

Reference 10

Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in South-Central Kentucky

By GORDON W. WEIR, ROBERT C. GREENE, *and* GEORGE C. SIMMONS

CONTRIBUTIONS TO STRATIGRAPHY

GEOLOGICAL SURVEY BULLETIN 1224-D

Prepared in cooperation with the Kentucky Geological Survey

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1965

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

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Washington, D.C. 20402 - Price 20 cents (paper cover)

CONTENTS

MEASURED SECTIONS

ILLUSTRATIONS

CONTRIBUTIONS TO STRATIGRAPHY

CALLOWAY CREEK LIMESTONE AND ASHLOCK AND DRAKES FORMATIONS (UPPER ORDOVICIAN) IN SOUTH-CENTRAL KENTUCKY

By Gordon W. Weir, Robert C. Greene, and George C. Simmons

ABSTRACT

Upper Ordovician rocks in south-central Kentucky are divided into lithologically distinct formations chiefly on the basis of contrasts in their mudstone and limestone content. From the top of the Garrard Siltstone to the top of the Ordovician are three newly defined map units; in ascending order, these are the Calloway Creek Limestone and the Ashlock and Drakes Formations.

The Calloway Creek Limestone is chiefly gray thin-bedded fossiliferous fine- to medium-grained limestone having partings and seams of greenish-gray shale; the lower part of the formation includes greenish-gray thin-bedded limy siltstone. The Calloway Creek ranges from about 80 to 130 feet in thickness.

The lower part of the Ashlock Formation is chiefly greenish-gray very sparsely fossiliferous limy and dolomitic mudstone; the middle part consists of bluish- and light-gray fossiliferous aphanitic to medium-grained and silty limestone; the upper part consists of greenish-gray unfossiliferous limy and dolomitic mudstone overlain by gray thin-bedded fossiliferous micrograined, medium-grained, and silty limestone. The Ashlock Formation ranges from about 125 to 145 feet in thickness.

The Drakes Formation is chiefly grayish-green unfossiliferous limy and dolomitic mudstone; the upper part contains thin beds of yellowish-gray sparsely fossiliferous fine-grained dolomitic limestone. The Drakes Formation ranges from about 120 to 150 feet in thickness.

INTRODUCTION

Geologic mapping and stratigraphic studies show the need for new names for lithologic divisions of the Upper Ordovician rocks in south-central Kentucky (figs. 1 and 2). Previous stratigraphic nomenclature (fig. 3), developed by stratigraphers during the early part of this century, was largely concerned with paleontological divisions of Upper Ordovician strata near Cincinnati, Ohio, and in southeastern Indiana. The development of the nomenclature of the Upper Ordovician rocks of Ohio and Indiana is beyond the scope of this paper, but it has been recently reviewed by Gutstadt (1958, p. 518–521), Weiss and Norman

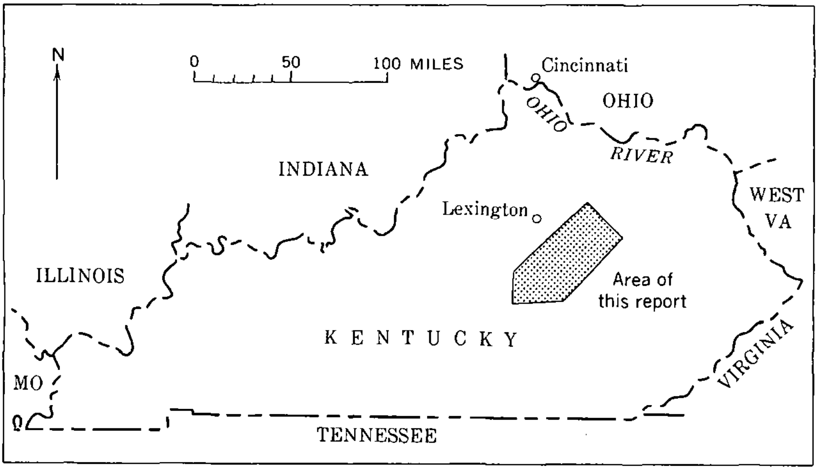

FIGURE 1.—Area of this report.

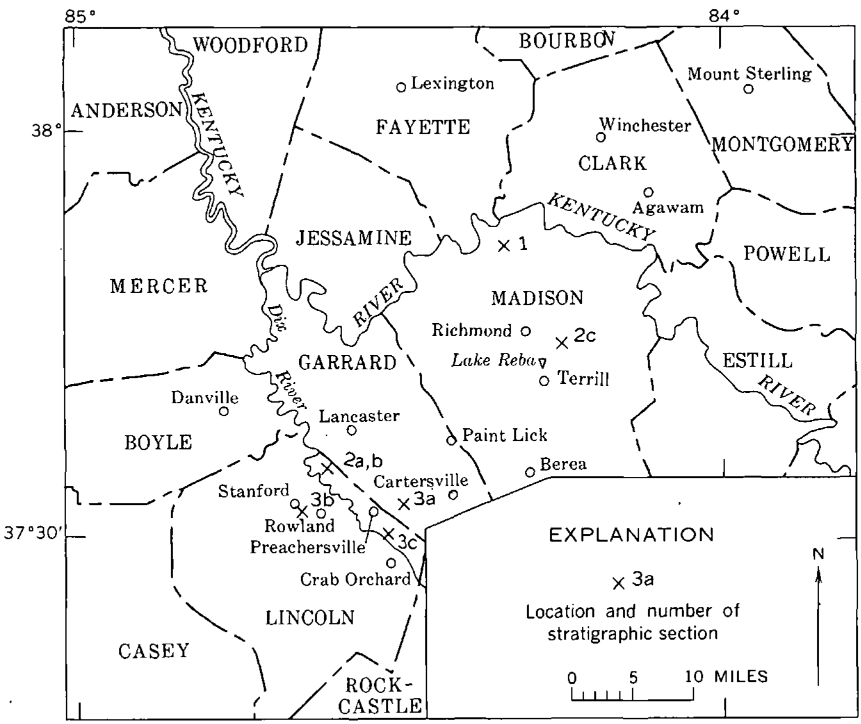

FIGURE 2.—Locations of stratigraphic sections in south-central Kentucky: 1, Calloway Creek; 2a, Ashlock Cemetery West; 2b, Ashlock Cemetery; 2c, Lake Reba; 3a, East Fork of Drakes Creek; 3b, Rowland West; 3c, Preachersville Southeast.

(1960), and Fox (1962, p. 622–628). These authors pointed out that there has been much confusion between faunal units and rock units. Most of the named divisions in Ohio and Indiana were characterized by their fossils rather than lithology. The names of these divisions, called formations and members, were applied in south-central Kentucky to presumed time-equivalent units whose fossils or stratigraphic relations were similar to those of named divisions in Ohio and Indiana.

Whatever the suitability of the previous nomenclature in Ohio and Indiana, the stratigraphic names used there are inadequate for the Upper Ordovician rocks of south-central Kentucky because the lithology of this part of the section changes markedly between the two regions. The Upper Ordovician section in south-central Kentucky contains more mudstone, argillaceous limestone, and micrograined to fine-grained limestone than the approximately equivalent section near the Ohio River.

The inadequacy of the nomenclature of the Cincinnati area for Upper Ordovician rocks of central Kentucky was long ago suspected by Foerste (1912, p. 22), who had earlier introduced many of the Ohio and Indiana names into Kentucky:

> Owing to the considerable lithological and accompanying faunal differences between the Cincinnatian strata as exposed in Ohio and Indiana, and their approximate stratigraphical equivalents in central Kentucky, it may prove convenient, locally, to recognize only the greater subdivisions of the Cincinnatian strata, as proposed at the typical section, at Cincinnati, Ohio, and to adopt a somewhat different set of subdivisions southward.

The following names of stratigraphic units whose type localities are in Ohio and Indiana and which have been applied to units in central Kentucky (fig. 3) are inappropriate for the Upper Ordovician lithologic divisions in south-central Kentucky: Fairview, Fairmount, McMillan, Mount Auburn, Arnheim, Oregonia, Waynesville, Whitewater, and Liberty. To this list is added the name Sunset, applied to a unit whose type locality is in northeast-central Kentucky. These names have been used for stratigraphic units whose limits are defined by their fossils or whose typical lithology is not present in south-central Kentucky. The names Garrard, Tate, and Gilbert are retained for rock-stratigraphic units whose type localities are in south-central Kentucky; these units are more fully defined later in this report.

The strata in the south-central part of the State are divided into lithologically distinct formations and members chiefly on the basis of contrasts between mudstone and limestone. The proposed nomenclature (fig. 3) includes three formations that are defined in this paper; these are, in ascending order, the Calloway Creek Limestone, and Ashlock and Drakes Formations. The type sections of these formations are described in measured sections 1 (p. D20), 2b (p. D24), and 3a (p. D30).

NOMENCLATURE Used by Palmquist and Hall (1960, 1961)			LITHOLOGY	NOMENCLATURE Used in this report		THICKNESS (FEET)		GENERALIZED DESCRIPTION
RICHMOND GROUP	Liberty and Whitewater formations undivided			DRAKES FORMATION	Preachersville Member	120-150	55-95	Silty mudstone as below and thin beds of argillaceous dolomitic limestone, yellowish-gray; relatively thick bed of dolomitic limestone near base, locally contains abundant fossils
	Waynesville limestone				Rowland Member		40-60	Silty mudstone, limy to dolomitic, grayish-green, thin-bedded, weathers yellowish gray; few megafossils
	Arnheim formation	Oregonia member of Foerste (1910)		ASHLOCK FORMATION	Reba Member	125-145	10-25	Limestone, chiefly medium-grained, silty, gray, thin-bedded, fossiliferous
		Sunset member of Foerste (1910)			Terrill Member		5-15	Limy shale, greenish-gray, platy; few megafossils
	McMillan formation	Mount Auburn shale member			Stingy Creek Member		5-15	Silty limestone and limy siltstone, fossiliferous grading at top to limy mudstone
		Gilbert limestone member of Foerste (1912)			Gilbert Member		10-20	Limestone, aphanitic to medium-grained, bluish-gray, thin-bedded, fossiliferous

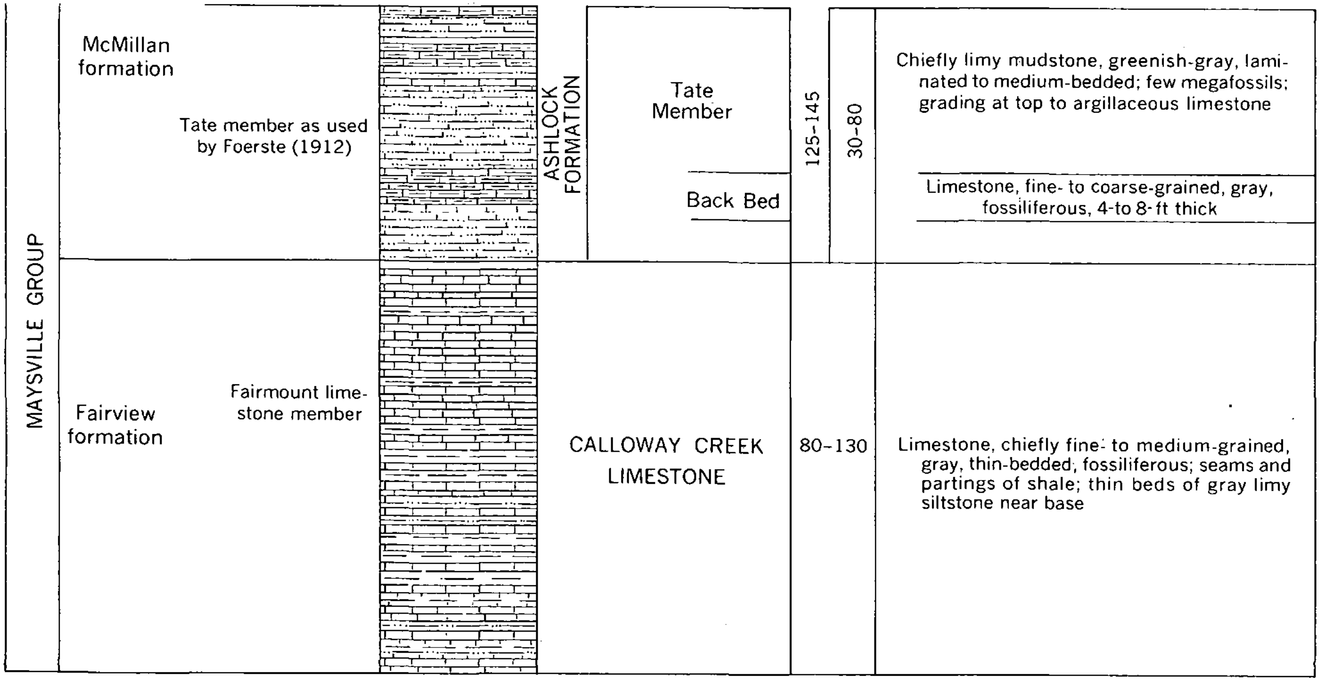

FIGURE 3.—Columnar section and nomenclature of Upper Ordovician rocks overlying the Garrard Siltstone in south-central Kentucky.

777-052 O—65——2

This report is based in large part on the geological mapping of Kentucky being conducted by the U.S. Geological Survey in cooperation with the Kentucky Geological Survey. Areas not currently being mapped were studied by the writers chiefly in late 1963 and early 1964. Of special help was the information contributed by E. R. Cressman, J. L. Gualtieri, W. L. Peterson, and F. A. Schilling, all of the U.S. Geological Survey.

GARRARD SILTSTONE

The Garrard Siltstone[1] (Campbell, 1898; Nosow and McFarlan, 1960, p. 43) underlies the Calloway Creek Limestone. The Garrard, named for Garrard County, Ky., is chiefly limy siltstone and minor mudstone and limestone. The siltstone is gray and very limy where fresh, but in most outcrops it is weathered yellowish brown where much of the carbonate has been leached out. Most beds are 6 to 24 inches thick; thicker beds are commonly contorted. Many of the beds are obscurely laminated. The interbedded mudstone and limestone are mostly in lenses a few inches thick and a few feet to a few tens of feet long. Fossils are sparse except for brachiopods in sporadic lenses of limestone. The Garrard Siltstone is a moderately resistant unit that is about 10 to 100 feet thick in the area between Danville and Mount Sterling.

CALLOWAY CREEK LIMESTONE

The Calloway Creek Limestone is here named for Calloway Creek in north-central Madison County, Ky. The type section (measured section 1, p. D20) was described from roadcuts of Interstate Highway 75, beginning about 0.4 mile south of the Kentucky River and extending southward to a point 0.6 mile north of Kentucky Highway 388 (fig. 4).

The Calloway Creek Limestone is composed chiefly of limestone with interbedded shale and minor siltstone. The characteristic appearance of the formation in fresh cuts is shown in figure 5. Limestone, which makes up about 70 to 80 percent of the formation, is mostly gray, fine to medium grained, and in uneven beds 0.1 to 0.3 feet thick. Greenish-gray limy shale makes up about 15 to 25 percent of the formation and is interbedded with the limestone as partings or seams and, near the base, as thin sets as much as 0.5 feet thick. Limy siltstone

[1] The Paint Lick Bed of Foerste (1906, p. 212), probably named for outcrops near the village of Paint Lick in Garrard County, was said to be the lower, more massive part of the Garrard (Foerste, 1909, p. 293, and 1912, p. 17, 49; McFarlan, 1943, p. 24; Nosow and McFarlan, 1960, p. 43). Mapping of the Garrard Siltstone in Garrard County and near Paint Lick shows no extensive divisions of the Garrard. The original definition of the Garrard by Campbell (1898), though generalized, is useful. The name Paint Lick is a later synonym of Garrard and is not used in this report.

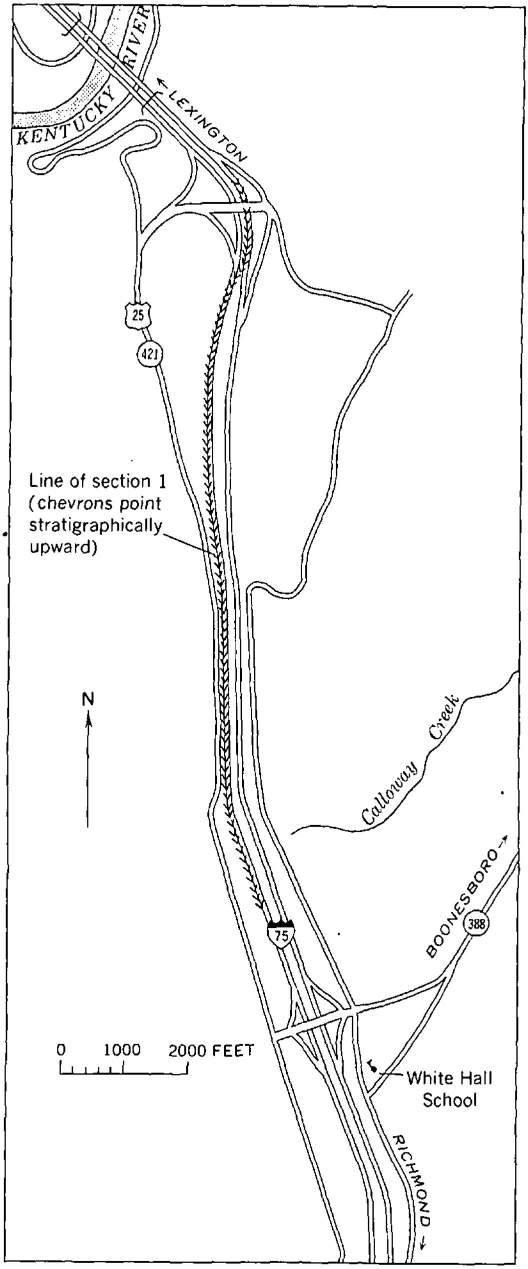

FIGURE 4.—Location of type section of the Calloway Creek Limestone, Madison County, Ky.

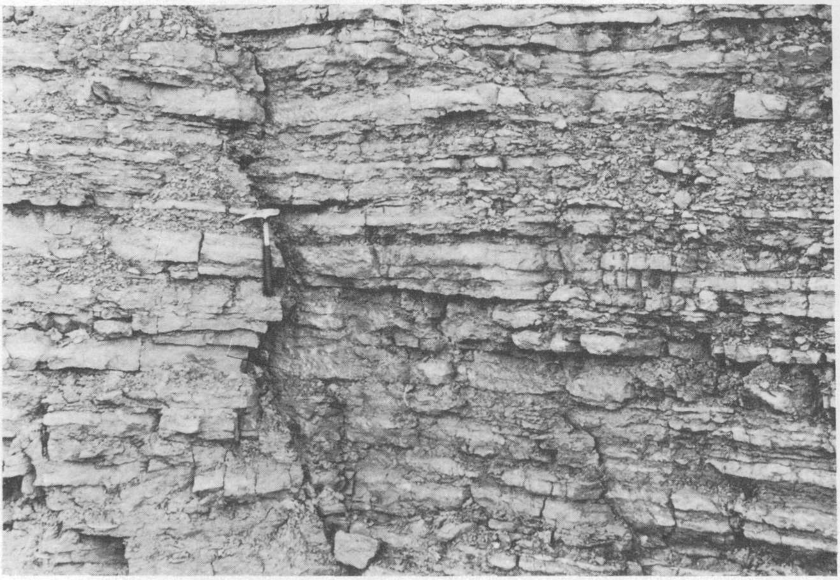

FIGURE 5.—Characteristic interbedding of granular limestone with seams and partings of shale near middle of the Calloway Creek Limestone. Type section of the Calloway Creek Limestone (measured section 1), roadcut on southbound lanes of Interstate Highway 75 about 1.5 miles south of the Kentucky River in Madison County, Ky.

makes up about 5 percent of the Calloway Creek and is in even beds less than 0.5 feet thick which are intercalated with shale and limestone in the lower third of the formation. The siltstone is gray to greenish gray, weathers yellowish brown, and resembles siltstone in the Garrard Siltstone. The formation is very fossiliferous. Brachiopods and bryozoans are the most abundant and conspicuous megafossils.

CONTACTS

The Calloway Creek Limestone is transitional with the underlying Garrard Siltstone and the overlying Ashlock Formation. The lower contact is placed so that all relatively persistent beds of limestone are included in the Calloway Creek. The contact generally lies above all siltstone beds more than 0.5 feet thick. The upper contact is placed so as to separate muddy limestone of the Calloway Creek from limy mudstone of the Ashlock.

EXTENT, THICKNESS, AND PROBABLE CORRELATIVES

The Calloway Creek Limestone has been mapped in Garrard and Madison Counties and has been recognized in sections from near Stanford to near Mount Sterling. The formation is about 125 feet thick at its type locality and ranges from about 80 to 130 feet in thickness. Previous workers have correlated the beds here included in the Calloway Creek Limestone with the Fairmount Limestone Member of the Fairview Formation of the Cincinnati area (McFarlan and Goodwin, 1930).

ASHLOCK FORMATION

The Ashlock Formation is here named for the Ashlock Cemetery near U.S. Highway 27 about 0.1 mile north of the Dix River in northeastern Lincoln County, Ky. The type section (measured section 2b, p. D24) was described from outcrops along the north bank of the Dix River and in roadcuts of U.S. Highway 27 north of the river (fig. 6).

The lower part of the Ashlock Formation is chiefly limy and dolomitic mudstone; the middle part is chiefly limestone and argillaceous limestone; and the upper part is greenish-gray unfossiliferous limy and dolomitic mudstone overlain by gray thin-bedded fossiliferous silty, granular limestone. Southwest of Richmond the formation is divisible into five members, which are in ascending order, the Tate, Gilbert, Stingy Creek, Terrill, and Reba Members.

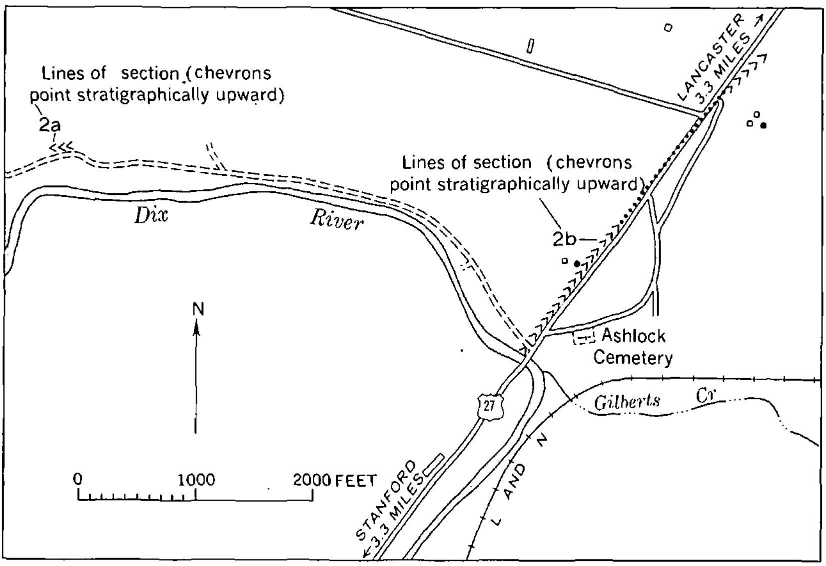

FIGURE 6.—Locations of type (2b) and reference (2a) sections of the Ashlock Formation, Lincoln County, Ky.

TATE MEMBER

The Tate Member, here designated as the basal member of the Ashlock Formation, was originally described as the Tate "layer" (Foerste, 1906, p. 212), later as the Tate Member of the McMillan Formation (Foerste, 1912, p. 48). It was probably named for outcrops along Tate Creek about 3 miles northwest of Richmond, Ky. Foerste (1912, p. 48) stated that the Tate was typically exposed in Madison County, but he did not describe a type section. The description for the Tate Member at the Ashlock Cemetery section (measured section 2b, p. D25) is representative of the lithology of the member.

The Tate Member is chiefly greenish-gray laminated to thin-bedded sparsely glauconitic, limy to dolomitic mudstone commonly grading at the top to argillaceous limestone (fig. 7). Purplish-gray medium-grained limestone, similar to limestone in the overlying Gilbert Member, occurs as a locally conspicuous unit, a few feet thick, about 10 to 15 feet below the top of the Tate.

About 5 to 15 feet above the base of the Tate is a persistent set, about 4 to 8 feet thick, of thin beds of olive-gray fine- to coarse-grained silty limestone containing silicified large brachiopods and bryozoans. This

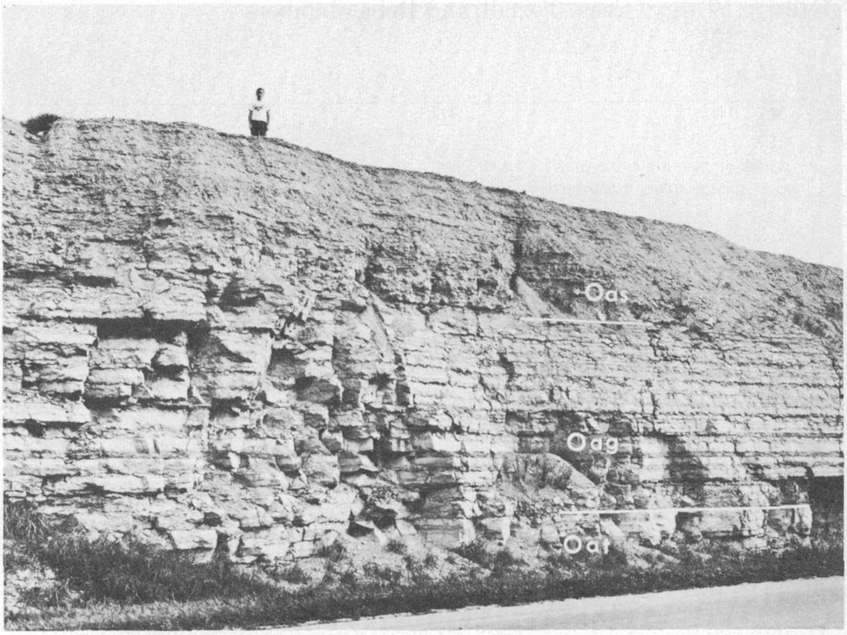

FIGURE 7.—Characteristic appearance in fresh cuts of the Tate Member (Oat), Gilbert Member (Oag), and Stingy Creek Member (Oas) of the Ashlock Formation. Type section of the Ashlock Formation, east side of U.S. Highway 27 about 0.5 mile north of the Dix River in Lincoln County, Ky. (See measured section 2b for description of units.)

unit, shown in figure 8, is a useful marker bed in south-central Kentucky and is here named the Back Bed of the Tate Member for representative outcrops along Back Creek in central Garrard County; the outcrop described in the Ashlock Cemetery section (measured section 2b, p. D26) is typical.

FIGURE 8.—Back Bed (below pick) of the Tate Member of the Ashlock Formation. Back Bed is light-gray fossiliferous limestone; rest of the Tate Member is chiefly greenish-gray limy mudstone. Roadcut on turnoff to Kentucky Highway 388 from northbound lanes of Interstate Highway 75, Madison County, Ky.

The Tate Member generally forms a moderate slope with light-colored platy fragments of mudstone. At the base of the member and just above the Back Bed many of the fragments are of silicified mudstone. The Back Bed and locally a few limy units in the upper part of the member form minor ledges. The member contains few megafossils except for brachiopods and bryozoans in the Back Bed.

The Tate Member south of the Kentucky River ranges from about 30 to 80 feet in thickness. Its maximum known thickness is near Lancaster; north and northeast of Richmond the upper part of the member grades to limestone and merges with an unnamed argillaceous and granular limestone member of the middle part of the Ashlock Formation. The Tate, including the Back Bed, has been identified in outcrops as far north as Mount Sterling.

GILBERT MEMBER

The Gilbert Member, here assigned to the Ashlock Formation, was named by Foerste (1912, p. 18, 23), probably for the village of Gilbert or for Gilberts Creek in northeastern Lincoln County, Ky. The member was sketchily defined by Foerste, but as used near Gilberts Creek by McFarlan and others (1927) and by McFarlan (1929) the name applies to a thin resistant sequence of limestone with partings of limy siltstone. The outcrop shown in figure 7 at the Ashlock Cemetery section (measured section 2b, p. D25) about 1 mile west of Gilbert is typical of the Gilbert Member. The limestone is bluish to olive gray, aphanitic to medium grained, and in crinkly beds a few inches thick. Gray limy siltstone occurs as partings and seams less than 1 inch thick. The member contains abundant well-preserved megafossils, chiefly brachiopods and bryozoans. The member is about 15 feet thick near Gilbert and ranges from about 10 to 20 feet in thickness. North and northeast of Richmond the Gilbert loses its identity as it grades laterally into an unnamed unit of nonresistant argillaceous and granular limestone.

STINGY CREEK MEMBER

The Stingy Creek Member of the Ashlock Formation is here named for representative outcrops of silty limestone and limy siltstone in roadcuts of Kentucky Highway 39 near Stingy Creek; the outcrop shown in figure 7 at the Ashlock Cemetery section (measured section 2b, p. D25) is typical. The limestone is chiefly medium light gray, fine to medium grained, and silty. It is obscurely thin bedded, partly in lenticles about an inch thick and a few inches long, and contains abundant brachiopods and bryozoans. The limy siltstone is chiefly light bluish gray and is gradational with the limestone with which it is interbedded. The Stingy Creek Member ranges from about 5 to 15 feet in thickness.

Northeast of Richmond it cannot be separated from the underlying part of the Ashlock Formation.

The Stingy Creek Member is transitional for a few feet with the overlying Terrill Member. The contact separates rock that is dominantly limestone from that above which is mainly mudstone.

TERRILL MEMBER

The Terrill Member is here named for outcrops near the settlement of Terrill, 4 miles south of Richmond. The type section of the member (measured section 2c, p. D28) is well exposed along Kentucky Highway 52 about 2 miles east of Richmond; the Ashlock Cemetery section (measured section 2b, p. D24) contains representative outcrops.

The Terrill is mainly composed of greenish-gray laminated limy or dolomitic mudstone as shown in figure 9. Weathered outcrops of the mudstone yield abundant small platy fragments. Many bedding surfaces are covered by ripple marks or mud cracks. The basal few feet of the member is a limy silty mudstone lacking distinct bedding. The member contains few megafossils. Bryozoans and brachiopods occur sparsely in the basal mudstone; and, locally, small chertified stromatolites occur near the top of the member. The Terrill Member ranges from about 5 to 15 feet in thickness and has been recognized in sections from near Stanford to near Winchester.

REBA MEMBER

The Reba Member is here named for its typical outcrops near Lake Reba on Kentucky Highway 52 about 2 miles east of Richmond (measured section 2c, p. D28); the Ashlock Cemetery section contains representative outcrops (measured section 2b, p. D24). The Reba Member is composed of micrograined limestone at the base, overlain by more or less silty, medium-grained limestone that at the top commonly grades into argillaceous limestone, as shown in figure 10. Limestone in the lower 2 to 6 feet of the member is commonly in ledge-forming beds as much as a foot thick, characteristically gray to grayish green, and aphanitic and micrograined to very fine grained; this limestone generally lacks megafossils but contains sparse ostracodes and abundant cylindrical markings a few millimeters across and a few centimeters long. Most of the limestone is fine to medium grained, has silty patches and partings, and is in uneven beds a few inches thick. Bedding is less distinct near the top where the limestone is more silty. The fine- to medium-grained limestone and argillaceous limestone contain abundant fossils, chiefly bryozoans and brachiopods. The member ranges from about 10 to 25 feet in thickness and has been recognized in sections from near Stanford to near Winchester.

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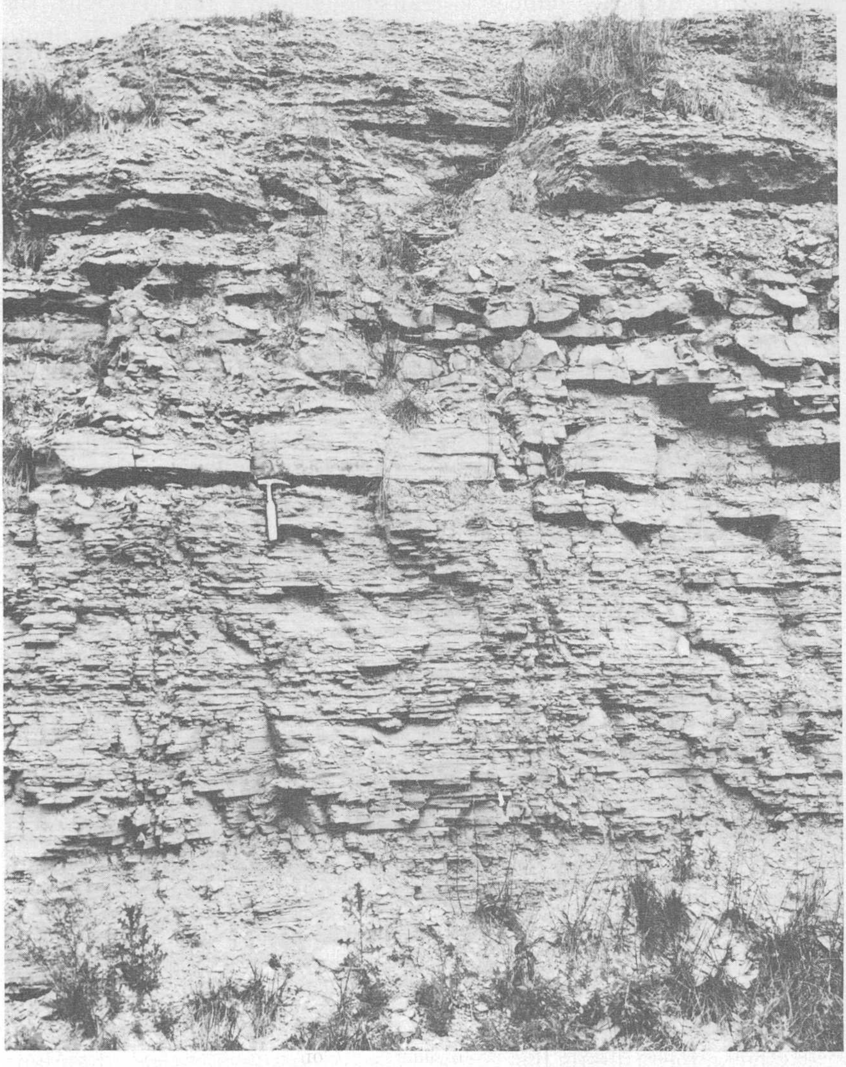

FIGURE 9.—Terrill and Reba Members of the Ashlock Formation. Below pick is greenish-gray laminated mudstone of the Terrill Member. Above pick is the Reba Member; at the base about 3 feet of micrograined limestone grading above to medium-grained limestone and silty limestone. Type section of the Ashlock Formation, U.S. Highway 27, about 3 miles south of Lancaster, Ky. (See measured section 2b for additional description of units.)

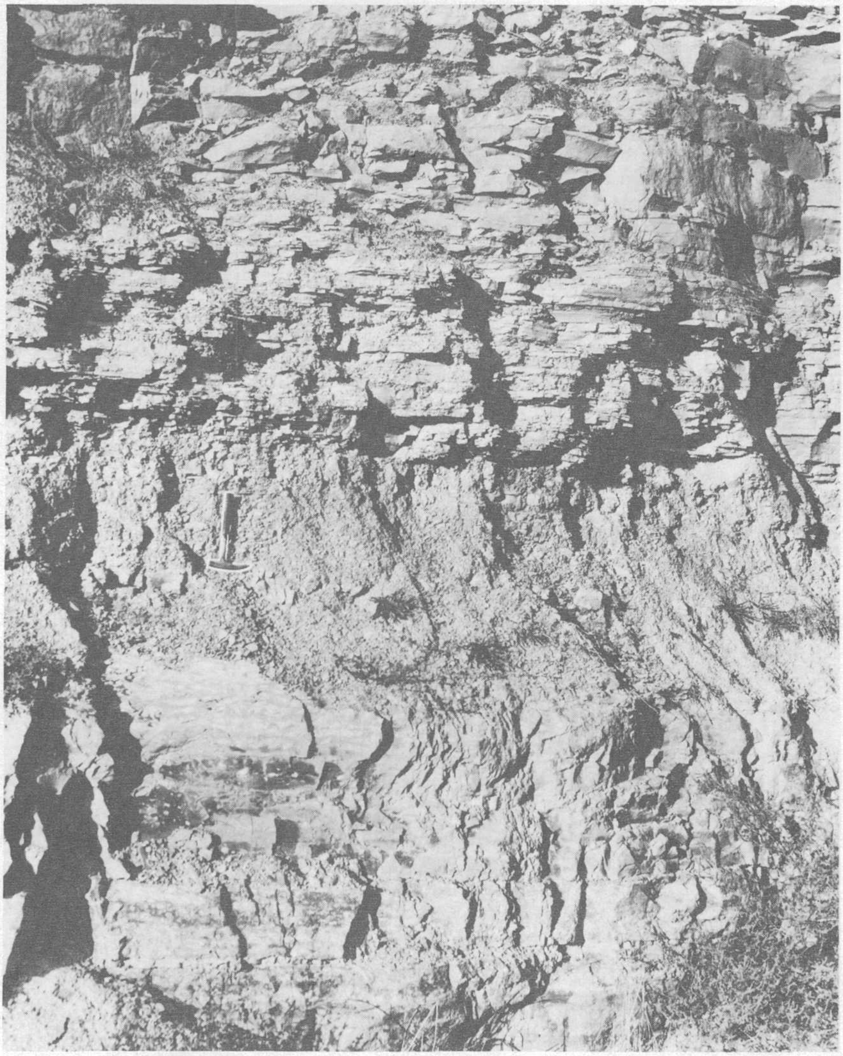

FIGURE 10.—Contact between the Reba Member of the Ashlock Formation and the Rowland Member of the Drakes Formation. Contact at pick head; silty limestone of the Reba Member below pick; transitional hackly weathering limy mudstone at pick assigned to the Rowland Member, platy-weathering limy mudstone about 1 foot above pick, characteristic of the Rowland Member. Lake Reba section about 2 miles east of Richmond, Madison County, Ky. (See measured section 2c for additional description of units.)

UPPER CONTACT

The lithologies of the Ashlock Formation and overlying Drakes Formation are transitional for several feet. As shown in figure 10 and described in measured sections 2b (p. D24), 2c (p. D28), and 3b (p. D33), the upper part of the Reba Member of the Ashlock Formation is fossiliferous argillaceous limestone. In many places the top few inches of the Reba is made up of hackly weathering limy mudstone with partings and lenticles of fossiliferous limestone; above it is similar mudstone but without the limestone lenticles. The top of mudstone containing limestone lenticles or, where this mudstone is absent, the top of argillaceous limestone is the upper contact of the Ashlock Formation. Limy mudstone above the contact is hackly weathering for a thickness of a few inches to a few feet and is gradationally or sharply overlain by platy weathering mudstone characteristic of the Rowland Member of the Drakes Formation.

EXTENT, THICKNESS, AND PROBABLE CORRELATIVES

The Ashlock Formation has been mapped in parts of Lincoln, Garrard, Madison, Estill, and Clark Counties and has been recognized in sections from near Stanford to near Mount Sterling. It ranges from about 125 to 145 feet in thickness.

Previous workers have correlated the beds here included in the Ashlock Formation with the McMillan and Arnheim Formations of Ohio (Palmquist and Hall, 1961, pl. 1). The Tate and Gilbert Members together were correlated with the Bellevue and Corryville Members of the McMillan, and the unit here named the Stingy Creek Member of the Ashlock was correlated with the Mount Auburn Shale Member of the McMillan (Nosow and McFarlan, 1960, p. 45, 46). Most of what is here called the Terrill Member has been referred to the Sunset Member of Foerste (1910) of the Arnheim, and most of what is here called the Reba Member has been referred to the Oregonia Member of Foerste (1910) of the Arnheim (McFarlan and Goodwin, 1930; Nosow and McFarlan, 1960, p. 47).

DRAKES FORMATION

The Drakes Formation is here named for Drakes Creek in southern Garrard County. The type section (measured section 3a, p. D30) was described from outcrops along and near a dirt road connecting Preachersville and Cartersville, beginning near the East Fork of Drakes Creek (fig. 11).

The Drakes Formation is divisible into two members, the Rowland Member below and the Preachersville Member above.

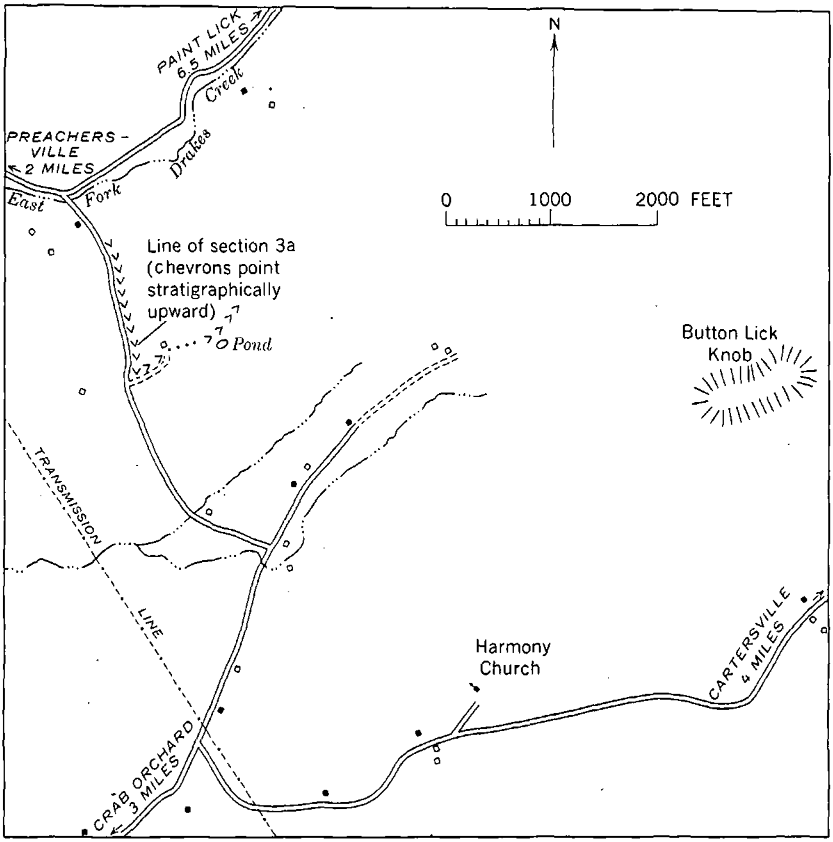

FIGURE 11.—Location of type section (3a) of the Drakes Formation, Garrard County, Ky.

ROWLAND MEMBER

The Rowland Member is here named for typical outcrops 1.3 miles west of Rowland on U.S. Highway 27 on the outskirts of Stanford, Ky. (measured section 3b, p. D32). It is chiefly composed of grayish-green dolomitic or limy, sparsely glauconitic silty mudstone (fig. 10). The mudstone is obscurely bedded in fresh roadcuts but weathers readily to platy fragments a fraction of an inch thick and a few inches across. Many bedding surfaces are covered by ripple marks or mud cracks. Megafossils are absent or very sparse. The member is nonresistant, crops out poorly, and forms smooth slopes. The Rowland Member ranges from about 40 to 60 feet in thickness and has been recognized in sections from near Stanford to near Winchester.

PREACHERSVILLE MEMBER

The Preachersville Member is here named for typical outcrops exposed on Kentucky Highway 39 about 2 miles southeast of Preachersville, Ky. (measured section 3c, p. D33.) It is similar to the Rowland Member but contains 10 to 20 percent argillaceous, fine-grained dolomite or dolomitic limestone in resistant beds, a few inches to a few feet thick (fig. 12); commonly, the thicker beds are near the base of the member. Some of the dolomitic beds contain abundant poorly preserved bryozoans and sparse brachiopods. Because the dolomite beds are fairly resistant, the member has a much more ledgy outcrop than the underlying Rowland Member. In part of northern Madison County, and more sporadically in Lincoln County, the base of the member is marked by as much as 6 feet of fossiliferous limestone containing abundant colonial corals and stromatoporoids. The Preachersville Member ranges from 55 to 95 feet in thickness and has been recognized in sections from near Stanford to near Mount Sterling.

UPPER CONTACT

In most of south-central Kentucky the Drakes Formation is in sharp contact with the overlying Brassfield Dolomite of Early Silurian age. The basal few feet of the Brassfield is commonly silty dolomite with streaks and patches of yellowish-gray mudstone derived from the underlying Drakes. Exceptionally, as 1 mile north of Berea on U.S. Highway 25, the basal few feet of the Brassfield is breccia containing fragments, as much as 4 inches across, of dolomitic mudstone derived from the Drakes Formation. In parts of south-central Kentucky, as near Stanford, Silurian rocks are missing, and the Drakes is unconformably overlain by the Boyle Limestone or New Albany Shale of Devonian age.

EXTENT, THICKNESS, AND PROBABLE CORRELATIVES

The Drakes Formation has been mapped in parts of Lincoln, Garrard, Clark, Madison, and Estill Counties and has been recognized in exposures from near Stanford to near Winchester. The formation is uncommonly well displayed in cuts along the Louisville and Nashville Railroad south of Agawam about 6 miles southeast of Winchester. The Drakes ranges from about 120 to 150 feet in thickness. The beds here included in the Rowland Member of the Drakes Formation were correlated with the Waynesville Limestone of Ohio, and the beds in the Preachersville Member of the Drakes were correlated with the Whitewater and Liberty Formations of Ohio and Indiana (Palmquist and Hall, 1961, pl. 1).

FIGURE 12.—Characteristic outcrop of the Preachersville Member of the Drakes Formation, showing interbedded ledgy fine-grained limy dolomite and hackly weathering limy and dolomitic mudstone. Roadcut on east side of U.S. Highway 27, about 2 miles south of Stanford, Lincoln County, Ky.

MEASURED SECTIONS

SECTION 1.—*Calloway Creek*

[Type section of the Calloway Creek Limestone; reference section of the Garrard Siltstone. Section measured in roadcuts along Interstate Highway 75 starting 0.4 mile south of the bridge over the Kentucky River and continuing southward for about 2 miles to a point 0.6 mile north of the Kentucky Highway 388 (Boonesboro road) overpass over Interstate 75, Madison County, Ky. (Richmond North and Ford quadrangles). (See fig. 4.) Measured with Jacob staff, Abney level, and tape by G. C. Simmons and P. E. Cassity, June 1963]

	Thickness (feet)
Ashlock Formation (incomplete) :	
Tate Member (incomplete) :	
12. Limestone, not measured.	
11. Shale, medium-gray (*N*4)[2], weathering grayish-green (5*G* 6/2)	9.0
Calloway Creek Limestone:	
10. Limestone, medium-gray (*N*5), medium-grained; in uneven beds mostly 0.2 to 0.3 ft thick but as much as 1.0 ft thick. Contains numerous inclusions, partings, and a few seams, as much as 0.1 ft thick, of greenish-gray (5*GY* 6/1 and 5*G* 6/1) shale. Upper 5 ft very argillaceous and grades into overlying shale of Tate Member of Ashlock Formation. Abundant fossils including brachiopods and bryozoans	15.8
9. Limestone (75 percent) interbedded with shale (25 percent). Limestone is medium gray (*N*5), medium grained, in uneven beds as much as 0.5 ft thick; numerous greenish-gray argillaceous inclusions. Shale is medium light gray (*N*6) to greenish gray (5*G* 6/1), limy, in partings and beds as much as 0.2 ft thick. Abundant brachiopods and bryozoans	13.1
8. Limestone (70 percent) interbedded with shale (30 percent). Two varieties of limestone are present. The more abundant limestone is medium light gray (*N*6) to medium dark gray (*N*4), finely mottled with white, very fine to medium grained; abundant greenish-gray argillaceous inclusions; fossiliferous. The less abundant limestone is medium dark gray (*N*4), very fine grained; fossils sparse. Both varieties of limestone are in uneven beds which average 0.2 ft in thickness and reach a maximum thickness of 0.5 ft. Shale is medium gray (*N*5) to greenish gray (5*G* 6/1), limy, in beds as much as 0.2 ft thick. Abundant fossils, especially brachiopods and bryozoans	21.4
7. Limestone (80 percent) interbedded with shale (20 percent). Limestone is medium gray (*N*5) to medium dark gray (*N*4), fine grained, in uneven beds 0.1 to 1.5 ft thick. Numerous greenish-gray argillaceous inclusions and partings. Shale is greenish gray (5*G* 6/1), limy. Abundant brachiopods and bryozoans	12.1

[2] Color names with numbers based on color chart by Goddard and others (1948).

SECTION 1.—*Calloway Creek*—Continued

Calloway Creek Limestone—Continued	*Thickness (feet)*
6. Limestone (60 percent) interbedded with siltstone (20 percent), and shale (20 percent). Limestone is light gray (*N*7) to medium dark gray (*N*4), light shades predominating, fine to medium grained, in uneven beds 0.3 to 0.4 ft thick. Numerous greenish-gray argillaceous and silty inclusions and partings. Siltstone is greenish gray (5*G* 6/1), limy, in beds as much as 0.3 ft thick. Shale is greenish gray (5*G* 6/1), limy, in beds 0.1 to 0.2 ft thick. Abundant fossils, chiefly in limestone, include brachiopods, bryozoans, and sparse crinoid columnals; many fossils are fragmental	24.3
5. Limestone (60 percent) interbedded with shale (40 percent). Limestone is light gray (*N*7) to medium dark gray (*N*4), lighter shades predominating, very fine to medium grained, in uneven beds as much as 1.0 ft thick. Abundant greenish-gray argillaceous inclusions. Shale is medium light gray (*N*6) to grayish green (5*G* 6/1), limy, in part silty, in beds as much as 0.5 ft thick. Abundant brachiopods and bryozoans	13.9
4. Limestone (50 percent) interbedded with siltstone (25 percent) and shale (25 percent). Limestone is medium light gray (*N*6) to medium dark gray (*N*4) and greenish gray (5*G* 6/1), fine to medium grained, in uneven beds as much as 0.5 ft thick. Siltstone is greenish gray (5*GY* 6/1) and weathers to dark yellowish brown (10*YR* 4/2) and dusky yellowish brown (10*YR* 2/2). Siltstone layers increase in number and in thickness toward the base of the unit; beds from less than 0.1 ft thick near the top to 0.5 ft thick near the base. Shale is medium light gray (*N*6) to grayish green, limy, in beds as much as 0.4 ft thick. Abundant fossils, mostly brachiopods. NOTE.—This interval is not completely exposed in the line of the measured section. Description is partly taken from exposures on a tributary to Smith Fork of Calloway Creek about 1,000 ft to the east of Interstate Highway 75	22.9
Total Calloway Creek Limestone	123.5

SECTION 1.—*Calloway Creek*—Continued

	Thickness (feet)
Garrard Siltstone:	
3. Siltstone (95 percent) interbedded with shale (5 percent). Siltstone is light greenish gray (5*GY* 7/1); weathers pale yellowish brown (10*YR* 4/2) to dusky yellowish brown (10*YR* 2/2) in natural exposures. The fresher rock contains abundant interstitial calcium carbonate making up as much as 25 percent of the rock. The more weathered dark- to dusky-yellowish-brown rock is not calcareous, has lighter specific gravity, and is punky. Beds are 0.3 to 3 ft thick; in general, the thicker beds occur toward the base of the unit; some beds are contorted. Shale is greenish gray (5*GY* 6/1) in partings and beds as much as 0.2 ft thick. Unit contains less than 5 percent limestone in thin lenses as much as 10 ft long and 0.2 ft thick; limestone is very light gray (*N*8) to medium gray (*N*5) and contains flakes and inclusions of siltstone and shale; moderately fossiliferous, chiefly brachiopods	12.3
2. Siltstone, light-greenish-gray (5*GY* 7/1), weathering pale-yellowish-brown (10*YR* 6/2). Where more intensely weathered is dark yellowish brown (10 *YR* 4/2) to dusky yellowish brown (10*YR* 2/2). Calcareous where not intensely weathered. Siltstone beds 0.3 to 8 ft thick with thicker beds toward base. Beds locally separated by thin shaly partings; a few beds in the lower 10 ft contain limestone stringers. Contorted beds common, characterized by flow rolls, rounded masses with complexly curved internal layering. Base gradational with limestone, shale, and siltstone of underlying unit; contact placed at top of highest persistent limestone bed of underlying formation; basal bed of Garrard is as much as 8 ft thick	21.7
Total Garrard Silstone	34.0

SECTION 2a.—*Ashlock Cemetery West*

[Reference section of the Ashlock Formation showing basal unit of the Ashlock Formation. Section measured along north bank of Dix River beginning 0.8 mile west of U.S. Highway 27, about 4 miles north of Stanford, Lincoln County, Ky. (Standford quadrangle). (See fig. 6.) Measured with Jacob staff and tape by G. W. Weir and J. C. Dills. October 1962.]

	Thickness (feet)
Ashlock Formation (incomplete):	
Tate Member (incomplete):	
5. Mudstone, limy and silty, greenish-gray (5*GY* 7/1), weathering greenish-gray (5*GY* 6/1); contains common to abundant flakes, 2 to 10 mm across, of bright-green clay mineral (glauconite?). Laminated to very thin bedded, 0.05 to 0.5 in. thick; smooth bedding surfaces; sparse irregular ripple marks about 27 ft above base; yields platy fragments 1 to 4 in. across; no megafossils. Thickness given is top of good outcrop; rest of Ashlock Formation is mostly covered. (See measured section 2b, p. D24.)	34.0
4. Limestone, light-gray (*N*7) to yellowish-gray (5*Y* 8/1), very fine grained, silty to coarse-grained. Partly in very thick sets with obscure bedding and partly in thin sets 1 to 2 ft thick with obscure layering a few inches thick; several limy shale partings, most conspicuous one is about 1 ft below top. Fossils common, chiefly large brachiopods, in part silicified. This unit is the Back Bed of the Tate Member, same as unit 2 of Ashlock Cemetery section	4.7
3. Mudstone, limy (95 percent) and silty limestone (5 percent). Limy mudstone is chiefly yellowish gray (5*Y* 7/2), laminated to very thinly bedded (0.05 to 1.0 in. thick); yields platy fragments; forms steep slope; common fine- to medium-sized fossil fragments, large bryozoans common about 3 to 4 ft above base. Silty limestone is yellowish gray to pale yellowish brown (10*YR* 6/2), very fine grained; sparse brachiopods; forms rough to smooth rounded ledge; occurs as single bed 0.5 ft thick, 5.5 ft below top of unit	11.6
Measured Ashlock Formation (incomplete)	50.3
Calloway Creek Limestone (incomplete):	
2. Limestone (90 percent) and limy shale (10 percent). Limestone is light gray (*N*7), chiefly fine to very fine grained and silty; becomes more silty upward, top 1 ft argillaceous and shaly weathering; in fairly even to slightly wavy beds 2 to 4 in. thick. Interbedded with 1- to 3-in. thick irregular seams of limy and silty shale containing lenticles and partings of limestone. Contact with overlying limy mudstone fairly sharp	9.0
1. Limestone (90 percent) and limy shale (10 percent), light-gray (*N*7) to medium-gray (*N*5), chiefly very fine grained to fine-grained and argillaceous, in uneven beds, commonly 1 to 4 in. thick. Fossils common, chiefly brachiopods. Partly covered; base of local exposure along road	8.5
Measured Calloway Creek Limestone (incomplete)	17.5

SECTION 2b.—*Ashlock Cemetery*

[Type section of the Ashlock Formation and of the Gilbert and Stingy Creek Members of the Ashlock Formation and of the Back Bed of the Tate Member of the Ashlock Formation. Measured chiefly along U.S. Highway 27 beginning at Dix River beneath bridge just west of mouth of Gilberts Creek and about 500 ft southwest of Ashlock Cemetery, Lincoln County, Ky., about 4 miles northeast of Stanford and 1 mile west of Gilbert (Lancaster quadrangle). (See fig. 6.) Measured with Jacob staff and tape by G. W. Weir and R. C. Greene, November 1961]

	Thickness (feet)
Drakes Formation (incomplete):	
Rowland Member (incomplete):	
15. Mudstone, limy and cherty, weathered to yellowish soil containing rectangular plates, 2 to 4 in. across, of white cherty shale weathering brownish gray and chips of grayish-yellow (5*Y* 8/4) limy and silty shale; unfossiliferous. Basal contact poorly exposed. Not measured; about 5 ft present; top of local exposure. Units 14b and 15 described from outcrops along abandoned road east of third roadcut north of Dix River.	
Ashlock Formation:	
Reba Member:	
14b. Limestone (50 percent) and silty limestone (50 percent). Limestone is greenish gray (5*GY* 6/1) to light olive gray (5*Y* 6/1); weathered rock is about same colors; fossils common to abundant, chiefly brachiopods and bryozoans; mostly in thin beds ½ to 2 in. thick and interbedded with silty limestone. Silty limestone is light greenish gray (5*GY* 6/1); weathered rock is same color and grayish yellow orange (10*YR* 8/6); in beds less than 2 in. thick; poor fissility; brachiopods and bryozoans common to abundant. At top is a few inches of greenish-gray (5*GY* 6/1) limy mudstone with partings of limestone; contains abundant small bryozoans. Whole unit forms steep rubbly, fossil-strewn slope in third roadcut north of bridge	12.4
14a. Limestone, light-olive-gray (5*Y* 6/1), aphanitic to micrograined; mostly in even beds 2 to 4 in. thick; abundant cylindrical markings about ⅛ in. in diameter and 1 to 2 in. long perpendicular to bedding, no megafossils. Resistant, forms projecting ledge. Transitional with coarser grained limestone above; top rather arbitrary. Units 11 through 14a described from east side of third roadcut north of the Dix River	2.6
Total Reba Member	15.0
Terrill Member:	
13. Mudstone, limy and silty, moderate-olive (10*Y* 7/2); upper part more limy than near base, very thin bedded, fissile along bedding; unfossiliferous except for sparse silicified stromatolites at top; in natural outcrops forms low slope littered with platy fragments. Upper 1 ft more limy, somewhat gradational into Reba Member; upper contact placed at conspicuous parting plane below first thick limestone bed of unit 14a	10.3

SECTION 2b.—*Ashlock Cemetery*—Continued

	Thickness (feet)
Ashlock Formation—Continued	
Terrill Member—Continued	
12. Mudstone, silty and sandy, greenish-gray (5*GY* 6/1) and light-greenish-gray (5*GY* 7/1); weathered rock is same colors; noticeable color contrast with underlying unit; much very fine sand admixed with silt; forms blocky ledge with irregular partings becoming more regular and very thin bedded upward; sparse large cylindrical bryozoans	1.3
11. Mudstone, silty and limy, medium-greenish-gray (5*GY* 5/1); a single bed with a hackly surface due to irregular fractures; sparsely fossiliferous, contains a few brachiopods and bryozoans	1.2
Total Terrill Member	12.8
Stingy Creek Member:	
10. Siltstone, limy (50 percent) and limestone (50 percent). Siltstone is dusky yellow (5*Y* 6/4), light bluish gray (5*B* 7/1), and moderately yellowish brown (10*Y* 5/4); limy, grading to silty limestone; very poor fissility. Limestone is medium light gray (*N*6); medium to coarse grained and silty; mostly in lumpy beds less than 3 in. thick. Limestone is about equal to siltstone in lower part of unit but less abundant and in more widely spaced beds in upper part. Whole unit very fossiliferous, contains chiefly brachiopods and bryozoans; less resistant than underlying unit; forms fossil-strewn slopes. Units 9 and 10 described from second roadcut north of the Dix River	14.2
Total Stingy Creek Member	14.2
Gilbert Member:	
9. Limestone with partings of limy siltstone, bluish-gray (5*B* 6/1), and light-olive-gray (5*Y* 6/1), weathering grayish-orange-brown (10*YR* 7/2), mostly fine grained, in part aphanitic; siltstone mostly in partings, less than 1 in. thick, in crinkly bedding planes that are a few inches apart. Abundant fossils, chiefly brachiopods and bryozoans; also scattered gastropods, cephalopods, and crinoid fragments; fossils are locally silicified	15.5
Total Gilbert Member	15.5
Tate Member (incomplete):	
8. Mudstone, silty, grading upward to argillaceous limestone. Silty mudstone is yellowish gray (5*Y* 7/2); contains much coarse silt; very limy with clusters of white calcite crystals. Argillaceous limestone is yellowish gray (5*Y* 7/2) and light olive gray (5*Y* 6/1), medium and fine grained. Unit is in even beds 6 to 12 in. thick, forms smooth rounded ledges, and contains sparse brachiopods and bryozoans. Units 6, 7, and 8 described from first roadcut north of Dix River	11.0

SECTION 2b.—*Ashlock Cemetery*—Continued

	Thickness (feet)
Ashlock Formation—Continued	
Tate Member (incomplete)—Continued	
7. Limestone, purplish-gray (5*P* 6/1) to medium-light-gray (*N*6), medium- to coarse-grained; small clusters and vugs of white coarsely crystalline calcite; beds 2 to 4 in. thick with crinkly surfaces separated by partings, less than 1 in. thick, of silty limestone that weather to knobby ledges; common brachiopods and bryozoans. Unit is similar to Gilbert Member, unit 9 above. Forms conspicuous dark band in fresh cuts	2.5
6. Mudstone, limy and silty (60 percent), and silty limestone (40 percent). Unit is greenish gray (5*GY* 6/1), weathers greenish gray (5*G* 6/1) and light olive gray (5*Y* 6/1); micrograined, fine grained and silty, purest limestone at base and top of unit; common to abundant scattered flakes of bright-green clay mineral (glauconite?), flakes mostly 2 to 5 mm across. Bedding planes commonly 6 in. to 2 ft apart. Conspicuous continuous parting plane 1.8 ft below top; forms near-vertical cliff in fresh roadcuts, but nearby weathered outcrops form rounded ledges less than 1 ft thick. Very sparse fragments of brachiopods and bryozoans	15.1
5. Covered. (For description of rocks in this interval see measured section 2a, p. D23, Ashlock Cemetery West.) Units 1 through 5 measured up cliff bordering Dix River	21.4
4. Limy mudstone (75 percent) and argillaceous limestone (25 percent); both medium grained; mudstone laminae are 1 to 25 mm thick, limestone beds about 1 in. thick in sets as much as 0.4 ft thick; forms steep, stepped slope littered with thin platy fragments	7.1
3. Mudstone, limy, greenish-gray (5*GY* 7/1); weathered rock is same color; in smooth laminae 1 to 20 mm thick. Scattered limy concretions, irregular discoidal lumps, a few inches in maximum diameter; fragments of brachiopods and bryozoans. Sparse large (0.5-in. diam) cylindrical bryozoans scattered through mudstone. Unit nonresistant, forms recess	3.2
2. Limestone, light-olive-gray (5*Y* 6/1) and light-gray (*N*7), weathering yellowish-gray (5*Y* 7/2), very fine to medium-grained and silty. Basal 1.3 ft consists of lenticles, 1 in. thick and 3 in. long, of medium-grained limestone in very thin bedded silty limestone matrix; very fossiliferous with large brachiopods. Middle 1.3 ft same as below but bedding less distinct. Shaly at top; fossils locally silicified; upper 1.1 ft is thin bedded with wavy bedding planes, unfossiliferous. Unit is Back Bed of Tate Member	3.7

SECTION 2b.—*Ashlock Cemetery*—Continued

	Thickness (feet)
Ashlock Formation—Continued	
Tate Member (incomplete)—Continued	
1. Mudstone, limy and dolomitic, greenish-gray (5*G* 6/1), weathering about grayish-yellow-green (5*GY* 7/2); in laminae and very thin beds as much as ½ in. thick; forms stepped cliff. About 5 ft exposed to bed of Dix River; estimated total thickness based on exposures about 1 mile west of highway. (See measured section 2a, p. D23, for description of fully exposed unit and of contact with underlying Calloway Creek Limestone.)	11.6
Total Tate Member	75.6
Total Ashlock Formation	133.1

SECTION 2c.—*Lake Reba*

[Type Section of the Terrill and Reba Members of the Ashlock Formation. Measured in roadcuts along Kentucky Highway 52, beginning about 2 miles east of Richmond, Madison County, Ky. (Moberly quadrangle). Measured with Jacob staff and tape by R. C. Greene and G. C. Simmons, December 1962; additional description by G. W. Weir, January 1964]

	Thickness (feet)
Drakes Formation (incomplete):	
Preachersville Member (incomplete):	
9. Mudstone (65 percent) and dolomitic limestone (35 percent). Mudstone is greenish gray (5*GY* 6/1); in even beds or sets of beds 1 to 6 in. thick, probably laminated in part; bedding generally obscure. Limestone is dolomitic and argillaceous, greenish gray (5*GY* 6/1), very fine to fine-grained; argillaceous patches and streaks; in even beds, 0.2 to 12 in. thick, thicker near top; makes up about 10 percent of unit near base, increasing to about 70 percent near top. Very sparse poorly preserved bryozoans. Thickness approximate; difference in altitude is 26.4 ft; dip is about ½° E. (approx) along line of section	30
8. Limestone, dolomitic and in part argillaceous, very pale yellowish brown (10*YR* 7/2) and medium-dark- to medium-light-gray (*N*4–6) and greenish-gray (5*GY* 6/1); weathered rock is same colors, faintly mottled grayish green and grayish orange; very fine grained; argillaceous to medium grained; coarser near top; in even beds 3 to 12 in. thick; forms resistant ledge. Sparse poorly preserved bryozoans	4.6
Measured Preachersville Member (incomplete; approximate)	35

SECTION 2c.—*Lake Reba*—Continued

	Thickness (feet)
Drakes Formation (incomplete)—Continued	
Rowland Member:	
7. Covered	5
6c. Mudstone, limy, light-olive- to greenish-gray (5*Y*, 5*GY*, 5*G* 6/1); sparse patches of green clay mineral (glauconite?); evenly laminated to very thin bedded in sets a fraction of an inch to as much as 18 in. thick; mostly splits along sets ¼ to ½ in. thick. No fossils seen. As a whole, nonresistant but more resistant than underlying unit; forms minor overhang at base. Thickness approximate; difference in altitude is 28.2 ft; dip is about ½° E. (approx) on line of section	35
6b. Mudstone, greenish-gray (5*GY* 6/1); bedding obscure; mostly nonfissile except for rough partings near top; face is coarsely hackly with many small angular and curving surfaces; along with underlying unit forms recess. Grades through a few inches into overlying unit, which unit resembles except for lack of bedding; basal contact sharp. No fossils seen	2.3
6a. Shale, limy, dark-greenish-gray (5*GY* 5/1); sparse glauconite(?); roughly laminated; weathered outcrop yields abundant fine chips; nonresistant; very sparse brachiopod(?) fragments at base; gradational through about 1 in. at base	.9
Total Rowland Member (approximate)	43
Measured Drakes Formation (incomplete; approximate)	78
Ashlock Formation (incomplete):	
Reba Member:	
5. Limestone, argillaceous, light-olive- to greenish-gray (5*Y*-, 5*GY* 5/1); minutely mottled with green clay mineral (glauconite?); fine grained. In even sets mostly 1 to 2 ft thick with obscure beds 2 to 3 in. thick. Moderately resistant; base locally forms minor overhang. Fossils common, mostly brachiopods and bryozoans	7.2
4c. Mudstone (70 percent) and limestone (30 percent). Mudstone is limy, medium dark gray (*N*4), roughly laminated, in sets 1 to 12 in. thick; no fossils seen. Limestone is medium gray (*N*5) to dark olive gray (5*Y* 3/1), fine grained, argillaceous, in lensing beds a few inches thick, mostly in basal 1 ft of unit. Unit nonresistant; forms recess	2.7
4b. Limestone (90 percent) and mudstone (10 percent). Limestone is medium gray (*N*5) and dark olive gray (5*Y* 3/1), aphanitic to coarse grained but mostly medium and coarse grained, fossil fragmental, sparse greenish-gray glauconite(?), and sparse pyrite. In even beds 2 to 12 in. thick, decreasing in thickness upward. Fossils common to abundant, low-spired gastropods especially abundant, brachiopod fragments common. Mudstone is dark gray (*N*3), limy; roughly laminated as partings and thin interbeds as much as 2 in. thick; unfossiliferous	3.0

SECTION 2c.—*Lake Reba*—Continued

	Thickness (feet)
Ashlock Formation—Continued	
Reba Member—Continued	
4a. Limestone, medium-light-gray (*N*6); mottled and streaked with light-gray (*N*7); aphanitic to fine-grained, mostly micrograined; sparse pyrite. Basal bed is 1.1 ft thick, overlain by sets of laminae and thin beds as much as 3 in. thick. Markedly resistant, base is prominent ledge. Mostly unfossiliferous except for sparse fragments of bryozoans and and brachiopods; ostracodes common in top layer; basal bed and some other layers characterized by fucoidal markings, nearly vertical cylinders of medium-light-gray fine-grained material in aphanitic matrix	2.6
Total Reba Member	15.5
Terrill Member:	
3. Mudstone, limy, greenish-gray (5*GY* 6/1 and 5*G* 6/1); mostly laminated and splitting smoothly along sets a fraction of an inch thick, but a few sets as much as 6 in. thick resemble unlaminated unit below; weathered outcrop yields abundant plates. Near top, 0.5 to 2.0 ft below contact, beds are very limy, grading toward micrograined limestone of overlying unit; top 0.5 ft is grayish-brown shale. Fossils absent except for sparse small fragments in limy beds near top	8.5
2. Mudstone, limy, light-olive- to greenish-gray (5*Y*-, 5*GY* 6/1), streaked and mottled with brownish-gray (5*YR* 4/1), weathering light-olive-gray to pale-olive (5*Y*-, 10*Y* 6/2); sparse fine-grained, greenish glauconite(?). A single set with faint irregular thin bedding, which is less distinct than bedding in overlying or underlying units. Weathers to an irregular face with smooth curving surfaces; nonresistant, forms recess. Base marked by 1 to 2 in. of dark-gray claystone, mostly plastic, water saturated. Fossils sparse, a few small cylindrical bryozoans	2.5
Total Terrill Member	11.0
Stingy Creek Member (incomplete):	
1. Limestone, argillaceous, medium-gray (*N*5), less commonly olive-gray (5*Y* 5/1), fine-grained, silty and clayey; roughly laminated in obscure sets 2 to 4 in. thick. Fossils common, mostly brachiopods and bryozoans. Base of local exposure	9.5
Measured Ashlock Formation (incomplete)	36.0

SECTION 3a.—*East Fork of Drakes Creek*

[Type section of the Drakes Formation. Measured about 5 miles due west of Cartersville and about 1 mile west of Button Lick Knob, Garrard County, Ky. Paint Lick quadrangle). Section begins about 500 ft southeast of East Fork of Drakes Creek and thence along dirt road connecting with road along Harmons Lick; at top of first hill (alt 1,014 ft) section measured along westward-trending ridge. (See fig. 11.) Measured with Jacob staff and rule by G. W. Weir and J. C. Dills, October 1962]

	Thickness (feet)
Brassfield Dolomite (incomplete; Silurian):	
11. Dolomite and limy dolomite, grayish-orange (5*Y* 8/4), streaked very dusky red (10*R* 2/2) and moderate-reddish-brown (10*R* 4/6); commonly coated with pale-yellowish-brown (10*YR* 6/2); fine to medium grained. Mostly weathered to dark-yellowish-orange (10*YR* 6/6) residuum which forms a sharp, conspicuous contact with the grayish-yellow soil of unit 19. Not measured; only about 5 ft present on hilltop; about 0.3 mile west of this point, Brassfield Dolomite is well exposed and is about 20 ft thick.	
Drakes Formation (Ordovician):	
Preachersville Member:	
10. Shale, silty, pale-greenish-yellow (10*Y* 8/2); in very thin beds 0.2 in. thick. Poorly exposed; mostly weathered to grayish-yellow (5*Y* 8/4) soil; nonresistant, forms gentle slope	17.0
9. Dolomite, limy and silty, grayish-orange (10*YR* 7/4), weathering grayish-yellow (5*Y* 8/4); in thin beds 1 in. thick; weathers to small irregular chunks; more resistant than overlying unit. In part very poorly exposed; probably contains some shaly siltstone	8.0
8. Dolomite, silty; probably similar to underlying unit but poorly exposed; probably contains much limy or dolomitic mudstone. At top is a bed of bryozoan silty dolomite that is yellowish gray (5*Y* 7/2) and spotted dark yellowish orange (10*YR* 6/6); finely crystalline, silty and very fine sandy; about 50 percent of the rock is made up of branching bryozoans, 1 to 4 mm in diameter; bed is 0.5 ft thick. (Section offset along top of this bryozoan dolomite bed—across small saddle east of barn to outcrops on point below stock pond.)	11.5
7. Dolomite, silty, grayish-yellow (5*Y* 8/4) to light-gray (*N*7), fine-grained, very fine sandy, in thin beds a few inches thick; forms minor bench; abundant very small bryozoans at top	1.3
6. Covered; grayish-yellow soil	6.3
5. Mudstone, dolomitic and silty (50 percent), and limy mudstone (50 percent); very poorly exposed. Dolomitic silty mudstone is light gray (*N*7), in thin beds 1 to 2 in. thick and interbedded with limy mudstone. Limy mudstone is pale olive (10*Y* 6/2), clayey, poorly laminated; somewhat plastic when wet	21.2

SECTION 3a.—*East Fork of Drakes Creek*—Continued

	Thickness (feet)
Drakes Formation (Ordovician)—Continued	
Preachersville Member—Continued	
4. Mudstone and dolomitic to argillaceous dolomite, light-gray (*N*7) to medium-gray (*N*6), weathering yellowish-gray (5*Y* 7/2 and 5*Y* 8/1), silty, in part limy; bedding obscure but lacks even bedding of underlying unit. Weathered surface has irregular nodular appearance suggestive of fossil markings; contains small nodules and streaks of light-orange calcite and dolomite, a few with sphalerite, perhaps recrystallized fossil material; no fossils seen. Fairly resistant, forms rough ledge	9.0
Total Preachersville Member	74.3
Rowland Member:	
3. Mudstone, limy, light-greenish-gray (5*G* 7/1) and grayish-yellow-green (5*GY* 7/2), weathering pale-olive (10*Y* 6/2); mostly limy, a few beds dolomitic, probably clayey in part as in 6-in.-thick bed about 20 ft above base. Unit appears unstratified internally in fresh cuts but weathers to thin beds less than 1 in. thick; ripple marks noted about 40 ft above base, mud cracks on slabs in float. Weathered outcrop yields platy fragments a fraction of an inch to several inches in diameter. Exposed in roadcut, little natural outcrop. No fossils seen	52.4
2. Mudstone, clayey; mostly covered on line of section. At base is seam of plastic claystone that is pale yellowish green (10*GY* 7/2) and a few inches thick; rest of unit is covered by platy debris from overlying unit. About 1,100 ft north of main line of section, most of this interval is well exposed and consists chiefly of mudstone that is light greenish gray (5*GY* 7/1) to greenish gray (5*GY* 6/1), very silty, and dolomitic to slightly limy; sparse dark-green spots of glauconite(?); appears structureless where fresh but is obscurely laminated and, where weathered, parts readily along smooth planes ¼ to ½ in. apart; yields platy fragments about ¼ in. thick and several inches in diameter; unfossiliferous. Basal 2.5 ft is clayey mudstone, generally similar to mudstone described but finer grained, more poorly bedded, and less fissile; sparse fragments of brachiopods in basal foot	8.3
Total Rowland Member	60.7
Total Drakes Formation	135.0
Ashlock Formation (incomplete):	
Reba Member (incomplete):	
1. Limestone, medium-light-gray (*N*6) and yellowish-gray (5*Y* 8/1); fine to medium grained, very argillaceous in top 5 ft; in rough-surfaced beds a few inches thick; abundant brachiopods and bryozoans. Not measured; about 15 ft exposed locally.	

SECTION 3b.—*Rowland West*

[Type section of the Rowland Member of the Drakes Formation. Measured in roadcuts along U.S. Highway 27 on outskirts of Stanford, about 1.2 miles west of Rowland, Lincoln County, Ky. (Stanford quadrangle). Measured with Jacob staff and rule by G. W. Weir, July 1964]

	Thickness (feet)
Drakes Formation (incomplete):	
Preachersville Member (incomplete):	
8. Limestone, dolomitic, grayish-orange (10*YR* 7/4), mottled light-olive-gray (5*Y* 5/1); weathered rock is about same color; commonly coated dark-olive-gray (5*Y* 3-4/1); very fine to fine grained; sparse scattered clusters, a fraction of an inch across, of orange and white coarsely crystalline calcite. In rough beds a few inches to about 1 ft thick with seams of mudstone as much as 2 in. thick; forms prominent ledge about 1 ft thick at base; minor, less prominent ledges above. Only basal foot well exposed near hilltop; thickness approximate	5.0
Rowland Member:	
7. Mudstone, dolomitic, light-greenish-gray (5*GY* 8/1) and yellowish-gray (5*Y* 7/2), weathering about grayish-orange (10*YR* 7/3) and pale-greenish-yellow (10*Y* 8/2); mostly silt probably with interstitial clay, and flakes of claystone a fraction of an inch across; in thin even beds a fraction of an inch to an inch thick; no megafossils. Less dolomitic, less resistant than underlying or overlying unit. Poorly exposed on gently slope	4.0
6. Mudstone, dolomitic, chiefly yellowish-gray (5*Y* 7/2), in part mottled dark-yellowish-gray (5*Y* 6/2), argillaceous, very fine grained; some beds probably argillaceous dolomite; in even beds ½ to 2 in. thick; cleaves along smooth partings ¼ to 1 in. apart; no megafossils; mottling perhaps of organic origin. More resistant than underlying and overlying units; forms ledge at top of roadcut, forms slope in natural outcrop	3.0
5. Mudstone, limy and dolomitic, greenish-gray (5*Y* 6/1), weathering yellowish-gray (5*Y* 7/2), argillaceous, very fine grained; some beds probably argillaceous limestone and dolomite with flakes and partings of mudstone; laminated and in even beds a fraction of an inch to several inches thick; splits along smooth partings a fraction of an inch to an inch apart; no megafossils	29.0
4. Mudstone, limy, greenish-gray (5*GY* 6/1), weathering light-olive-gray (5*Y* 6/1) and yellowish-gray (5*Y* 7/2), argillaceous, very fine grained; some beds probably argillaceous limestone; dark-green glauconite(?) common near base; discontinuous siliceous white band, 0 to 2 in. thick, about 8.5 ft above base; laminated and in thin even beds commonly ¼ to 1 in. thick, a few beds several inches thick; bedding obscure in fresh cuts but brought out by weathering; cleaves readily along smooth partings ⅛ to 1 in. apart; weathered outcrop yields plates and blocks; no megafossils noted. Top placed at top of hackly weathering interval 1 to 3 ft thick, forming minor niche. More resistant than underlying unit but along with units 8, 9, and 10 forms moderate slope	22.1

SECTION 3b.—*Rowland West*—Continued

	Thickness (feet)
Drakes Formation (incomplete)—Continued	
Rowland Member—Continued	
3. Mudstone, greenish-gray (5*GY* 6/1), slightly limy; dark-green glauconite(?) common; crudely laminated; weathers to small chips; no megafossils; nonresistant, forms niche below more resistant mudstone of unit 7	0.9
Total Rowland Member	59
Measured Drakes Formation (incomplete)	64
Ashlock Formation (incomplete):	
Reba Member (incomplete):	
2. Mudstone (75 percent) and limestone (25 percent). Mudstone is greenish gray (5*GY* 6/1), limy, crudely laminated; weathers to small chips. Limestone is argillaceous, greenish gray (5*GY* 6/1), very fine grained, intermixed with mudstone; fossils fragmental; common grayish-green clay mineral (glauconite?); in lenticles ⅛ to ¼ in. thick and a few inches long scattered through mudstone; very fossiliferous, contains abundant fine to very coarse fragments of bryozoans and brachiopods. Nonresistant unit, forms fossil-strewn slope. Presence of limestone differentiates this unit from overlying unit; contact placed at top of limestone lenticles interstratified with mudstone	1.0
1. Limestone, argillaceous, greenish-gray (5*G* 6/1); weathered rock is about same color; poorly sorted, very fine to coarse grained, but mostly fine to medium grained; intermixed with 10 to 40 percent mudstone; obscurely bedded, probably in crenulated beds 1 to 3 in. thick. Very fossiliferous, chiefly bryozoans and brachiopods. Nonresistant, weathers to fossil-strewn rubbly slope. Not measured; about 10 ft exposed in highway cut and ditch.	

SECTION 3c.—*Preachersville Southeast*

[Type section of the Preachersville Member of the Drakes Formation. Measured southward in gully and roadcuts along Kentucky Highway 39 beginning about 2 miles southeast of Preachersville, Lincoln County, Ky. (Lancaster quadrangle.) Measured with Jacob staff and rule by G. W. Weir, July 1964. Thicknesses adjusted for local dip of 2° SE.]

Brassfield Dolomite (incomplete; Silurian):

10. Limestone, dolomitic, pale-grayish-orange (10*YR* 8/4), with streaks of dark-yellowish-orange (10*YR* 6/6); very fine to fine grained; in rough beds several inches thick; no fossils noted. Mostly weathered to moderate-yellowish-brown (10*YR* 5/4) soil with scattered blocks a few inches to a few feet across. Not measured; residuum is about 3 ft thick on hilltop at end of section about 800 ft southeast of starting point.

SECTION 3c.—*Preachersville Southeast*—Continued

	Thickness (feet)
Drakes Formation (incomplete; Ordovician):	
Preachersville Member:	
9. Shale, silty and probably dolomitic, moderate- to pale-greenish-yellow (10*Y* 7–8/2); in smooth even laminae and thin beds as much as 1 in. thick; very fissile along bedding planes; nonresistant, forms gentle slope. No fossils noted	20
8. Mudstone (80 percent) and limy argillaceous dolomite (20 percent). Mudstone is light greenish gray (5*GY* 7/1), slightly limy, mostly obscurely bedded, in part laminated; hackly weathering yielding small chunks commonly ⅛ to ½ in. across; no megafossils noted; curly markings ⅛ in. across and several inches long resembling worm tracks in lower part of unit; makes up lower ⅔ of unit and interbedded with dolomite in top ⅓. Dolomite is limy, argillaceous, pale grayish orange (10*YR* 8/2) and light greenish gray (5*GY* 7/1), very fine grained, in even beds about 1 in. thick; no fossils noted. Unit forms slope with ledgy top	4.5
7. Dolomite (70 percent) and mudstone (30 percent). Dolomite is argillaceous and limy, yellowish gray (5*Y* 7/2) to grayish orange (10*YR* 7/3), chiefly very fine and fine grained, with streaks of greenish-gray mudstone; in somewhat rough beds ¼ to 1½ in. thick; sparse poorly preserved cylindrical bryozoans in a few thin beds. Mudstone is dolomitic, light greenish gray (5*GY* 7/1) to yellowish gray (5*Y* 8/1); common to abundant intermixed fine-grained dolomite; in obscure and irregular, lumpy discontinuous beds commonly ¼ to 1½ in. thick; closely interstratified with dolomite; no fossils noted. Whole unit relatively resistant, sets of beds of dolomite form ledges	15.5
6. Mudstone, dolomitic; similar to dolomitic mudstone in overlying unit 7; nonresistant, forms slope; very sparse poorly preserved small cylindrical bryozoans	6
5. Dolomite (50 percent) and mudstone (50 percent). Dolomite is argillaceous, yellowish gray (5*Y* 7/2–8/1) and medium gray (*N*5), and pale orange (10*YR* 7/2), very fine to fine grained, silty; intermixed streaks and patches of mudstone; slightly limy, with clusters, ⅛ to ½ in. across, of pale-yellowish-orange calcite crystals; mostly in fairly even beds 1 to 3 in. thick; base marked by uneven bed 4 to 8 in. thick; muddier parts contain common "worm" markings, about ⅛ in. across, emphasized by slight color contrasts; very sparse poorly preserved bryozoans. Mudstone is dolomitic, greenish gray (5*GY* 6–7/1); contains intermixed grayish-orange (10*YR* 7/3) stringers and patches of very fine grained dolomite; obscurely bedded; hackly weathering; common "worm" markings and very sparse very poorly preserved small cylindrical bryozoans and small fragments of brachiopods(?). Whole unit relatively resistant; beds of dolomite form minor ledges	16
4. Mudstone, dolomitic, grayish-green (5*G* 6–7/1); similar to mudstone in unit 5; less resistant than underlying or overlying unit	11

SECTION 3c.—*Preachersville Southeast*—Continued

	Thickness (feet)
Drakes Formation (incomplete; Ordovician)—Continued	
Preachersville Member—Continued	
3. Mudstone, limy (50 percent), grading to fossiliferous argillaceous limestone (35 percent) and, at top, grading to dolomitic mudstone (15 percent); yellowish gray (5*Y* 8/2), greenish gray (5*GY* 6/1 and 5*G* 6/1); weathered rocks are same colors and light olive gray (5*Y* 6/1) and light greenish gray (5*G* 7/1). At base is about 1 ft of poorly bedded unfossiliferous limy mudstone, overlain by about 2 ft of very limy mudstone containing common to abundant lenticles, a few inches long and less than an inch thick, of fossiliferous argillaceous limestone, grading to fossiliferous argillaceous limestone with a few seams of mudstone and in top 1 ft grading to unfossiliferous resistant dolomitic mudstone; separated from dolomitic mudstone of unit 4 by conspicuous parting, commonly iron stained. Bedding generally obscure throughout unit. Limy rocks sparsely to abundantly fossiliferous; most conspicuous are colonial corals, as much as 2 ft across in layer about 2 ft below top of unit; smaller colonial corals and stromatoporoids common about 2.5 ft below top; brachiopods and bryozoans, sparse to very abundant beginning about 2 ft above base and continuing to about 1.5 ft below top. Unit generally nonresistant, upper half of unit more resistant than lower half	5.5
2. Limestone, argillaceous, olive-gray (5*Y* 5/1) to greenish-gray (5*GY* 6/2), weathering light-olive-gray (5*Y* 7/1), to light-greenish-gray (5*GY* 7/1), chiefly very fine grained, silty, probably clayey in part; small geoidal clusters, ¼ to 1 in. across, of coarsely crystalline white calcite; a single set of rough beds ¼ to 2½ in. thick, many bedding planes discontinuous; forms small but prominent rough ledge. Sparse very fine and fine-grained fossil fragments of brachiopods bryozoans(?)	1.5
Total Preachersville Member	80
Rowland Member (incomplete):	
1. Mudstone, chiefly yellowish-gray (5*Y* 8/1), in places grayish-yellowish-green (5*GY* 6–7/2); weathered rock is same colors or darker, approximately pale olive (10*Y* 6/1); slightly to very limy, silty; in even laminae and thin beds as much as 2 in. thick; fissile, cleaving along smooth partings ¼ to 1 in. apart; nonresistant, forms slope; outcrop yields chips and small plates, a fraction of an inch to a few inches across, and irregular blocks commonly about ¼ in. thick and 1 to 3 in. long; no fossils seen. In part poorly exposed; about 75 percent of interval is outcrop. Base of section is base of local exposure	13
Measured Rowland Member (incomplete)	13
Measured Drakes Formation (incomplete)	93

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Reference 11

Groundwater Availability

Alluvium (Qa)

Topography

The alluvium forms narrow floodplains and small terraces along the Kentucky River and larger tributaries.

Hydrology

The alluvium yields 100 to 500 gallons per day to wells in thick deposits along the Kentucky River; elsewhere, the alluvium is too thin and fine-grained to yield much water. Water is hard.

High-Level Fluvial Deposits (QTf)

Topography

These deposits blanket localized areas of uplands and hilltops having no distinct surface expression.

Hydrology

These deposits yield 100 to 500 gallons per day to wells in thick deposits; otherwise, they are too thin and scattered to be important as an aquifer. They do yield water to small springs and dug wells. Water is soft.

Breathitt Group (Pikeville Formation) (Pbl)

Topography

The Breathitt Group underlies the valleys and forms the hills of the southeastern corner of the county. Tops of hills and ridges commonly are capped by sandstone. Shales form wide valleys and moderate or gentle slopes on hills.

Hydrology

The Breathitt yields more than 500 gallons per day to almost half of the wells drilled in valley bottoms and more than 100 gallons per day to about half the wells drilled on hillsides and on ridges. Sandstones yield water to most wells. Shales also yield water to many wells, and coal yields water to a few. Near-vertical joints and openings along bedding planes yield most of the water to wells. Waters are highly variable in chemical character

Corbin Sandstone Member, Grundy, and Bee Rock Formations (contains Lee type sandstone of the former Lee Formation) (Plc)

Topography

These rocks form the tops of steep-sided ridges and knobs, steep bluffs, and cliffs. Some sandstone paleochannels have been cut through shales of the Paragon Formation into limestone units of Late Mississippian age.

Hydrology

These rocks yield 100 to 500 gallons per day to drilled wells on broad ridges, but almost no water to wells on narrow ridges or hilltops. They do yield water to small springs. Water is soft.

Paragon Formation (Mpk)

Topography

The Paragon is too thin and limited in extent to have distinct surface expression.

Hydrology

The Paragon yields almost no water. Impermeable shale may hold water in overlying sandstone and conglomerate.

Slade Formation (in southeastern corner) (Mpn, Mn)
Topography
In the southeastern corner of the county, these limestone beds form steep hillsides and prominent bluffs in sides of ridges and knobs that are capped by Pennsylvanian rocks.

Hydrology
The Slade yields 100 to 500 gallons per day to drilled wells in the few places where it occurs below stream level. It yields almost no water to wells on narrow ridgetops or hillsides, but does yield water to small springs on hillsides, particularly at the heads of streams. Springs have large winter and small summer flows. Water is hard to very hard.

Borden Formation (MDbb, Mbf)
Topography
The Borden forms the main part of the Mississippian Escarpment, ridges, and knobs. Shale forms dissected slopes, massive siltstone forms cliffs, and limestone forms ledges on shale slopes.

Hydrology
The Borden yields 100 to 500 gallons per day to wells in valley bottoms. It may yield more than 500 gallons per day to drilled wells in broad valley bottoms from fractured sandy rocks near streams. It yields almost no water to wells on hills. Water from wells drilled below stream level may contain salt, sulfate, or iron less than 100 feet below the level of the principal valley bottoms. Water from dug wells and small springs is soft and has a low dissolved-solids content. Water from shale is soft; from the siltstone, hard; and from the limestone, very hard. Because much of this formation is soft and silty, it has been well suited to the construction of dug wells in the past.

New Albany Shale (MDnb)
Topography
The New Albany forms broad, flat valleys and flat uplands. It forms steep, dissected hillsides and bluffs along streams.

Hydrology
The New Albany yields 100 to 500 gallons per day to drilled wells in valley bottoms and on uplands, usually at depths of less than 50 feet; water from greater depths is highly mineralized. The shale yields water to small springs. Water may be soft or highly mineralized. Salt, hydrogen sulfide, and iron are the usual objectionable constituents.

Boyle Dolomite (MDnb)
Topography
The Boyle forms resistant ledges on valley sides between shale slopes above and below.

Hydrology
The Boyle yields almost no water to drilled wells. It does yield water to many small perennial springs. Water is hard, but otherwise of good quality.

Crab Orchard Formation and Brassfield Dolomite (Scb)
Topography
The shale forms steep, dissected hillsides and broad, flat valley bottoms. The shale erodes readily below more-resistant overlying limestone, forming notches and recesses. Dolomite beds form discontinuous ledges along hillsides.

Hydrology
The shale yields almost no water to wells or springs, but may yield small amounts of water to

wells in valley bottoms. Water is highly mineralized. Dolomite beds yield hard water to small springs.

Drakes Formation (Od)
Topography
The Drakes forms dissected upland areas, with slopes that are moderately steep where underlain by shale, and moderately undulating to gently rolling where underlain by limestone. The Drakes forms steep and cliffy slopes along large streams, littered with limestone slabs left as shale beds weather and wash away.

Hydrology
The Drakes yields 100 to 500 gallons per day to drilled wells in broad valleys and along streams in upland, but almost no water to drilled wells on hillsides or ridgetops. It does yield water to small springs. Water is hard, and in valley bottoms may contain salt or hydrogen sulfide. Shale limits the amount of water that has access to thick limestone beds, and therefore restricts the number of openings in these beds enlarged by solution. As a result, the limestone beds yield little water.

Ashlock Formation and Calloway Creek Limestone (Oaf)
Topography
These rocks form gently to moderately rolling uplands away from major streams. The formation is highly dissected where shale content increases, with small sinkholes, minor underground drainage, and broad, flat valleys where limestone predominates.

Hydrology
These formations yield 100 to 500 gallons per day to drilled wells in broad valleys and along streams in uplands, but almost no water to drilled wells on hillsides or ridgetops. They do yield water to small springs. Water is hard, and in valley bottoms may contain salt or hydrogen sulfide. Where thick limestone beds with little shale occur below stream level in valley bottoms or on uplands, they may have undergone solutional enlargement of fractures and bedding-plane openings. Wells drilled into these limestone beds may produce more than 500 gallons per day. These thick beds also yield water to some large springs.

Garrard Siltstone (Okc)
Topography
The Garrard forms prominent ledges along hillsides.

Hydrology
The well-cemented siltstone and fine-grained sandstone and siltstone do not provide many openings for water, and yield almost no water to wells. Water is hard.

Clays Ferry Formation and Kope Formation (Okc)
Topography
These formations create the rugged topography of narrow, steep-sided ridges with narrow V-shaped valleys of dendritic drainage. Steep slopes erode easily and are covered with thin limestone slabs in many places. In the lower part of the formation, topography becomes more gently to moderately rolling uplands with small sinkholes and some underground drainage where limestone predominates.

Hydrology
These formations yield 100 gallons per day to drilled wells in valley bottoms, but almost no water to drilled wells on hillsides or ridgetops. They do yield water to small springs. In the lower, limestone-rich section, drilled wells can yield 100 to 500 gallons per day in valley bottoms along streams. Water is hard in valley bottoms, and may contain salt or hydrogen

sulfide. Shale has small, poorly connected openings, and groundwater circulation is slow; as a result, little water is available to wells and springs. On ridgetops, the shale prevents downward percolation of water, and creates small semiperched water bodies in the lower part of the soil and the upper part of weathered bedrock.

Upper Part of Lexington Limestone (Tanglewood Limestone, Millersburg, Strodes Creek, Devils Hollow, Sulfur Well, Brannon, and Perryville Members) (Ol)

Topography

The upper Lexington forms broad, flat valleys in uplands. Where dominantly limestone, it has well-developed subsurface drainage and many sinkholes, with gently sloping hillsides adjacent to small streams in uplands. The resistant shale and soft, bentonite-rich beds form a subdued bench-like topography along hillsides and streams.

Hydrology

The upper Lexington yields more than 500 gallons per day to wells in valley bottoms and along streams in uplands. It yields 100 to 500 gallons per day to many perennial springs and more than 100 gallons per minute to a few large springs. The amount of water available in rocks of the Lexington Limestone is dependent on the amount of shale. Generally, throughout the whole Lexington Limestone section, the more shale found within the zone of interest, the less water will be found. The upper Lexington yields water to springs from the resistant Brannon Member. Water is hard, and may contain salt or hydrogen sulfide in some places. Water from wells near fault zones may contain objectionable amounts of salt.

Lower Part of Lexington Limestone (Ol) (Grier, Logana, Curdsville Members)

Topography

The lower Lexington forms rolling to dissected uplands. Sinkholes are very common; the large ones occur in the Grier Limestone. Natural outcrops are rare in the rolling uplands, but the limestone beneath hillslopes is evident from the bench-like or terrace-like appearance of the slopes. Limestone crops out in discontinuous bands in the valley sides in the dissected part near the Kentucky River.

Hydrology

The lower Lexington yields 100 to 500 gallons per day to wells in most valley bottoms and along streams in uplands; it yields up to 150 gallons per minute from thick limestone beds in the Curdsville along large streams. The lower Lexington also yields water to many small springs. Water is hard, and may contain salt in valley bottoms.

High Bridge Group (Tyrone Limestone, Oregon Formation, Camp Nelson Limestone) (Ohb)

Topography

The High Bridge forms steep slopes and high cliffs along the Kentucky and Dix Rivers and lower parts of tributaries. The Camp Nelson forms flat terraces with occasional sinkholes in the bottom of the Kentucky River gorge and steep cliffs along the lower sides. It also extends up the large tributaries, forming flat bottoms and steep walls. The Oregon crops out in a band in the walls of the gorge and up a few large tributaries. The Tyrone crops out in the upper walls of the Kentucky River gorge and extends up the large tributaries nearly to the uplands, forming broad, flat valleys with sinkholes and underground drainage.

Hydrology

The High Bridge yields 100 to more than 500 gallons per day to drilled wells in valleys of the Dix and Kentucky Rivers and large tributaries. Yields of as much as 225 gallons per minute have been reported in wells drilled into the Camp Nelson Limestone adjacent to the Kentucky River, from solution channels and fractures connected with the river. The High Bridge yields water to springs on hillsides and in steep walls along large streams. Water is hard, and may contain hydrogen sulfide, but generally is of good quality. Wells drilled into the High Bridge through overlying rocks produce almost no water, because bentonite beds in the Tyrone prevent recharge to underlying rocks, except where the bentonite has been breached or removed by erosion.

Knox Group (Okx)

Topography

The Knox Group has no surface exposure in Kentucky, but underlies the entire state at varying depths.

Hydrology

In the Inner Bluegrass Region of Kentucky, fresh water has been found in the upper 100 to 250 feet of this largely untested dolomite-rich aquifer. Wells often exceed 750 feet in total depth, with high concentrations of dissolved solids found in many areas. Average reported yields range from 10 to 20 gallons per minute, but as high as 75 gallons per minute.

You can find out more about the Knox aquifer.

The U.S. Geological Survey's Hydrologic Atlas Series, published cooperatively with the Kentucky Geological Survey, provides hydrologic information for the entire state.

Previous--Next--Back to "Groundwater Resources in Kentucky"

Reference 12

LOCATION CALEAST KY

Established Series
Rev. JHW:JHN
02 2006

CALEAST SERIES

The Caleast series consists of deep and very deep, well drained soils that formed in residuum weathered from limestone interbedded with thin strata of calcareous shale and siltstone. Slopes range from 2 to 20 percent.

TAXONOMIC CLASS: Fine, mixed, active, mesic Mollic Hapludalfs

TYPICAL PEDON: Caleast silt loam--cultivated. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 7 inches; dark brown (10YR 3 3) silt loam, brown (10YR 5 3) dry; moderate fine and medium granular structure; friable; many fine roots; neutral; clear smooth boundary. (6 to 10 inches thick)

Bt1--7 to 13 inches; dark yellowish brown (10YR 4 4) silty clay; moderate fine and medium angular blocky structure; firm; many fine roots; many faint clay films; few fine (1-2 mm) black (10YR 2 1) Mn nodules; neutral; gradual smooth boundary. (0 to 10 inches thick)

Bt2--13 to 23 inches; dark yellowish brown (10YR 4 4) silty clay; moderate fine and medium angular blocky structure; very firm; common fine roots; many faint clay films; few fine (1-2 mm) black (10YR 2 1) Mn nodules; slightly acid; gradual smooth boundary. (5 to 20 inches thick)

Bt3--23 to 54 inches; yellowish brown (10YR 5 4) clay; common medium faint light yellowish brown (2.5Y 6 4) and dark yellowish brown (10YR 4 4) lithochromic mottles; moderate fine and medium angular blocky structure; very firm; few fine roots; many faint clay films; few fine (1-2 mm) black (10YR 2 1) Mn nodules; common black (10YR 2 1) Mangans on faces of peds; slightly acid. (10 to 35 inches thick)

R--54 inches; limestone interbedded with thin strata of calcareous shale and siltstone.

TYPE LOCATION: Madison County, Kentucky; about 4.7 miles southwest of Richmond and 1.5 miles west of Caleast, thence 0.1 mile north on farm road on ridgetop, and 175 yards east in pasture field.

RANGE IN CHARACTERISTICS: Depth to limestone bedrock is 40 to more than 80 inches. Solum thickness is 40 to 60 inches. reaction ranges from moderately to mildly alkaline. Fragments of limestone range from 0 to 5 percent by volume.

The A horizon has hue of 7.5YR to 2.5Y, value of 3, and chroma of 2 to 4. Value dry is less than 6. Texture is silt loam or silty clay loam.

Some pedons have thin BE or BA horizons up to 8 inches thick with colors and textures similar to the upper Bt.

The upper part of the Bt horizon has hue of 7.5YR to 2.5Y, value of 4 or 5, and chroma of 3 to 6. Texture is silty clay loam or silty clay.

The lower part of the Bt horizon has similar colors, but commonly has lithochromic mottles in shades of brown, yellow or gray. Texture is silty clay or clay.

A BC or C horizon with textures similar to the lower Bt is in some pedons. It is commonly variegated without dominant hue or chroma and includes chroma of 2 or less.

COMPETING SERIES: These are the Belpre, Brooke, Fleming, McAfee and Salvisa series in the same family. Belpre soils have redder colors in the argillic horizon and lack Mn nodules. Brooke, McAfee and Salvisa soils are moderately deep to bedrock. Fleming soils have paralithic contact and redder colors in the argillic horizon.

GEOGRAPHIC SETTING: Caleast soils are on upland ridgetops and side slopes. Slopes range from 2 to 20 percent and some areas are karst. The soils formed in clayey residuum weathered from limestone interbedded with thin layers of shale and siltstone. The average annual temperature is about 54 degrees F., and average annual precipitation is about 45 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cynthiana, Lowell, Fairmount, Faywood, and Lowell, Maury, Salvisa and Shelbyville series. Cynthiana, Faywood, Lowell, Maury and Salvisa soils do not have mollic epipedons. Shelbyville soils are fine-silty. Cynthiana and Fairmount soils are shallow. Faywood and Salvisa soils are moderately deep.

DRAINAGE AND PERMEABILITY: Well drained with moderately slow permeability. Runoff is medium on slopes less than 5 percent and high on slopes greater than 5 percent.

USE AND VEGETATION: Nearly all areas are used for growing hay, corn, tobacco, and small grains or as pasture. Native vegetation is chiefly hardwoods interspersed with grassy glades. The dominant tree species are oaks, black walnut, hickory, ash, hackberry, elm and maple.

DISTRIBUTION AND EXTENT: The Bluegrass region of Kentucky and possibly southwestern Ohio. Total extent probably is moderate.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Morgantown, West Virginia

SERIES ESTABLISHED: Madison County, Kentucky; 1968.

National Cooperative Soil Survey
U.S.A.

United States Department of Agriculture

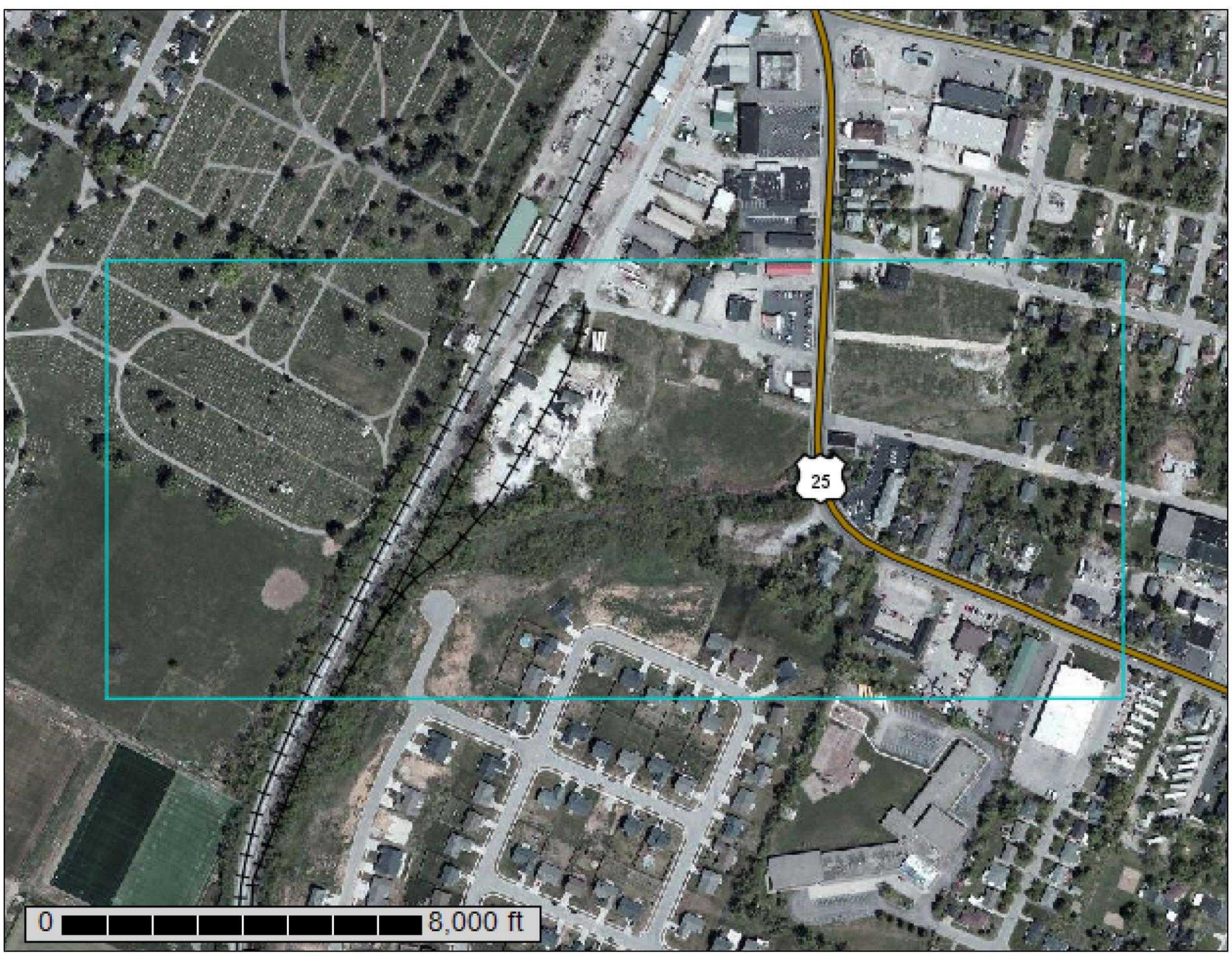
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Madison County, Kentucky



May 25, 2016

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

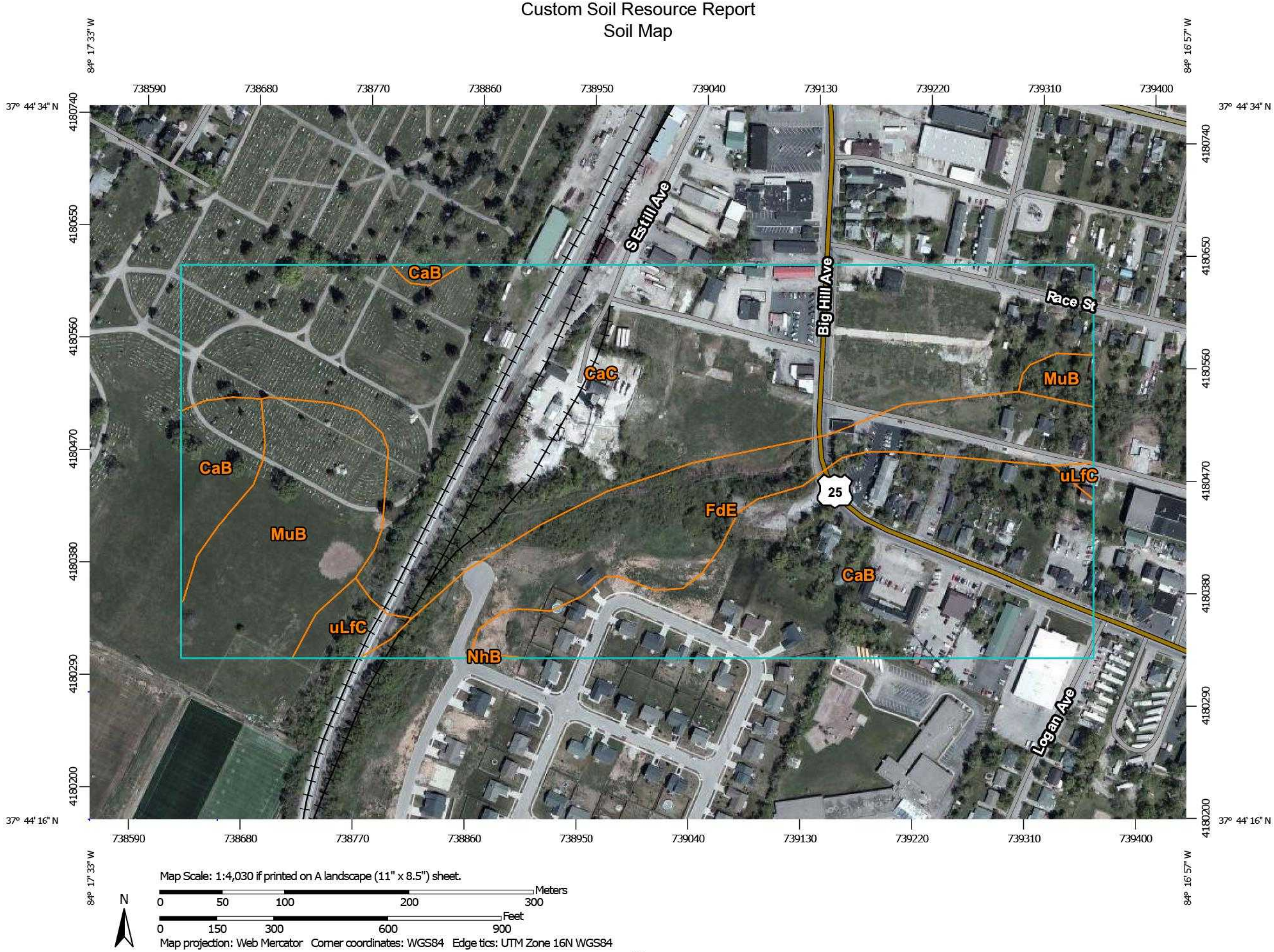
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map


84° 17' 33" W
84° 16' 57" W
37° 44' 34" N
37° 44' 16" N
738590
738680
738770
738860
738950
739040
739130
739220
739310
739400
4180740
4180650
4180560
4180470
4180380
4180290
4180200
CaB
CaC
MuB
uLfC
FdE
NhB
25
S Estill Ave
Big Hill Ave
Race St
Logan Ave
N
Map Scale: 1:4,030 if printed on A landscape (11" x 8.5") sheet.
Meters
0 50 100 200 300
Feet
0 150 300 600 900
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)
Area of Interest (AOI)

Soils
Soil Map Unit Polygons
Soil Map Unit Lines
Soil Map Unit Points

Special Point Features
Blowout
Borrow Pit
Clay Spot
Closed Depression
Gravel Pit
Gravelly Spot
Landfill
Lava Flow
Marsh or swamp
Mine or Quarry
Miscellaneous Water
Perennial Water
Rock Outcrop
Saline Spot
Sandy Spot
Severely Eroded Spot
Sinkhole
Slide or Slip
Sodic Spot

Spoil Area
Stony Spot
Very Stony Spot
Wet Spot
Other
Special Line Features

Water Features
Streams and Canals

Transportation
Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background
Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Madison County, Kentucky
Survey Area Data: Version 13, Sep 15, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 17, 2010—Sep 13, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Madison County, Kentucky (KY151)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
CaB	Caleast silt loam, 2 to 6 percent slopes	15.4	26.8%
CaC	Caleast silt loam, 6 to 12 percent slopes	27.2	47.5%
FdE	Faywood silt loam, 12 to 30 percent slopes	7.6	13.3%
MuB	Mercer silt loam, 2 to 6 percent slopes	6.1	10.7%
NhB	Nicholson silt loam, 2 to 6 percent slopes	0.0	0.0%
uLfC	Lowell-Faywood silt loams, 6 to 12 percent slopes	0.9	1.6%
Totals for Area of Interest		**57.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Madison County, Kentucky

CaB—Caleast silt loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 1hxkw
Mean annual precipitation: 37 to 53 inches
Mean annual air temperature: 44 to 65 degrees F
Frost-free period: 176 to 212 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Caleast and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Caleast

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Clayey residuum weathered from limestone

Typical profile

H1 - 0 to 7 inches: silt loam
H2 - 7 to 23 inches: silty clay
H3 - 23 to 54 inches: clay
R - 54 to 64 inches: unweathered bedrock

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Minor Components

Lowell

Percent of map unit: 3 percent

Faywood

Percent of map unit: 2 percent

Nicholson

Percent of map unit: 2 percent

Other soils

Percent of map unit: 2 percent

Shelbyville

Percent of map unit: 1 percent

CaC—Caleast silt loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 1hxkx
Mean annual precipitation: 37 to 53 inches
Mean annual air temperature: 44 to 65 degrees F
Frost-free period: 176 to 212 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Caleast and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Caleast

Setting

Landform: Ridges
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Clayey residuum weathered from limestone

Typical profile

H1 - 0 to 7 inches: silt loam
H2 - 7 to 23 inches: silty clay
H3 - 23 to 54 inches: clay
R - 54 to 64 inches: unweathered bedrock

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: 40 to 80 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C

Minor Components

Other soils

Percent of map unit: 5 percent

Lowell

Percent of map unit: 5 percent

Faywood

Percent of map unit: 3 percent

Cynthiana

Percent of map unit: 2 percent

FdE—Faywood silt loam, 12 to 30 percent slopes

Map Unit Setting

National map unit symbol: 1hxlr
Mean annual precipitation: 37 to 53 inches
Mean annual air temperature: 44 to 65 degrees F
Frost-free period: 176 to 212 days
Farmland classification: Not prime farmland

Map Unit Composition

Faywood and similar soils: 70 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Faywood

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey residuum weathered from limestone

Typical profile

H1 - 0 to 6 inches: silt loam
H2 - 6 to 30 inches: silty clay
R - 30 to 40 inches: unweathered bedrock

Properties and qualities

Slope: 12 to 30 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained

Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C

Minor Components

Other soils

Percent of map unit: 10 percent

Fairmount

Percent of map unit: 5 percent

Cynthiana

Percent of map unit: 5 percent

Caleast

Percent of map unit: 5 percent

Lowell

Percent of map unit: 5 percent

MuB—Mercer silt loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 1hxm8
Mean annual precipitation: 37 to 53 inches
Mean annual air temperature: 44 to 65 degrees F
Frost-free period: 176 to 212 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Mercer and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mercer

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear

Parent material: Fine-silty residuum weathered from phosphatic limestone

Typical profile

H1 - 0 to 9 inches: silt loam
H2 - 9 to 23 inches: silty clay loam
H3 - 23 to 40 inches: silty clay loam
H4 - 40 to 70 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: 17 to 28 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 18 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: D

Minor Components

Beasley

Percent of map unit: 2 percent

Lowell

Percent of map unit: 2 percent

Other soils

Percent of map unit: 2 percent

Hagerstown

Percent of map unit: 2 percent

Shelbyville

Percent of map unit: 1 percent

Lawrence

Percent of map unit: 1 percent
Landform: Flats, stream terraces

NhB—Nicholson silt loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2s2cz
Elevation: 460 to 1,140 feet
Mean annual precipitation: 35 to 59 inches
Mean annual air temperature: 42 to 68 degrees F

Frost-free period: 135 to 218 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Nicholson and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nicholson

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Fine-silty noncalcareous loess over clayey residuum weathered from limestone

Typical profile

Ap - 0 to 8 inches: silt loam
Bt - 8 to 28 inches: silt loam
Btx - 28 to 38 inches: silty clay loam
2Bt - 38 to 50 inches: clay
2C - 50 to 80 inches: clay

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: 16 to 30 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 13 to 27 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C

Minor Components

Lawrence

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Trees/Timber (Woody Vegetation)

Lowell

Percent of map unit: 5 percent
Landform: Ridges

Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve, side slope
Down-slope shape: Convex
Across-slope shape: Linear

uLfC—Lowell-Faywood silt loams, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2s2d6
Elevation: 450 to 1,130 feet
Mean annual precipitation: 36 to 66 inches
Mean annual air temperature: 40 to 68 degrees F
Frost-free period: 144 to 218 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Lowell and similar soils: 70 percent
Faywood and similar soils: 20 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lowell

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Clayey residuum weathered from limestone and shale

Typical profile

Ap - 0 to 8 inches: silt loam
Bt - 8 to 41 inches: silty clay
BC - 41 to 53 inches: silty clay
R - 53 to 63 inches: bedrock

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: 40 to 57 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 3 percent
Available water storage in profile: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C

Description of Faywood

Setting

Landform: Hills
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Clayey residuum weathered from limestone and shale

Typical profile

Ap - 0 to 7 inches: silt loam
Bt - 7 to 29 inches: silty clay
R - 29 to 39 inches: bedrock

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: 20 to 39 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D

Minor Components

Cynthiana

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear

Sandview

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex

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LOCATION CALEAST KY

Established Series
Rev. JHW:JHN
02 2006

CALEAST SERIES

The Caleast series consists of deep and very deep, well drained soils that formed in residuum weathered from limestone interbedded with thin strata of calcareous shale and siltstone. Slopes range from 2 to 20 percent.

TAXONOMIC CLASS: Fine, mixed, active, mesic Mollic Hapludalfs

TYPICAL PEDON: Caleast silt loam--cultivated. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 7 inches; dark brown (10YR 3 3) silt loam, brown (10YR 5 3) dry; moderate fine and medium granular structure; friable; many fine roots; neutral; clear smooth boundary. (6 to 10 inches thick)

Bt1--7 to 13 inches; dark yellowish brown (10YR 4 4) silty clay; moderate fine and medium angular blocky structure; firm; many fine roots; many faint clay films; few fine (1-2 mm) black (10YR 2 1) Mn nodules; neutral; gradual smooth boundary. (0 to 10 inches thick)

Bt2--13 to 23 inches; dark yellowish brown (10YR 4 4) silty clay; moderate fine and medium angular blocky structure; very firm; common fine roots; many faint clay films; few fine (1-2 mm) black (10YR 2 1) Mn nodules; slightly acid; gradual smooth boundary. (5 to 20 inches thick)

Bt3--23 to 54 inches; yellowish brown (10YR 5 4) clay; common medium faint light yellowish brown (2.5Y 6 4) and dark yellowish brown (10YR 4 4) lithochromic mottles; moderate fine and medium angular blocky structure; very firm; few fine roots; many faint clay films; few fine (1-2 mm) black (10YR 2 1) Mn nodules; common black (10YR 2 1) Mangans on faces of peds; slightly acid. (10 to 35 inches thick)

R--54 inches; limestone interbedded with thin strata of calcareous shale and siltstone.

TYPE LOCATION: Madison County, Kentucky; about 4.7 miles southwest of Richmond and 1.5 miles west of Caleast, thence 0.1 mile north on farm road on ridgetop, and 175 yards east in pasture field.

RANGE IN CHARACTERISTICS: Depth to limestone bedrock is 40 to more than 80 inches. Solum thickness is 40 to 60 inches. reaction ranges from moderately to mildly alkaline. Fragments of limestone range from 0 to 5 percent by volume.

The A horizon has hue of 7.5YR to 2.5Y, value of 3, and chroma of 2 to 4. Value dry is less than 6. Texture is silt loam or silty clay loam.

Some pedons have thin BE or BA horizons up to 8 inches thick with colors and textures similar to the upper Bt.

The upper part of the Bt horizon has hue of 7.5YR to 2.5Y, value of 4 or 5, and chroma of 3 to 6. Texture is silty clay loam or silty clay.

The lower part of the Bt horizon has similar colors, but commonly has lithochromic mottles in shades of brown, yellow or gray. Texture is silty clay or clay.

A BC or C horizon with textures similar to the lower Bt is in some pedons. It is commonly variegated without dominant hue or chroma and includes chroma of 2 or less.

COMPETING SERIES: These are the Belpre, Brooke, Fleming, McAfee and Salvisa series in the same family. Belpre soils have redder colors in the argillic horizon and lack Mn nodules. Brooke, McAfee and Salvisa soils are moderately deep to bedrock. Fleming soils have paralithic contact and redder colors in the argillic horizon.

GEOGRAPHIC SETTING: Caleast soils are on upland ridgetops and side slopes. Slopes range from 2 to 20 percent and some areas are karst. The soils formed in clayey residuum weathered from limestone interbedded with thin layers of shale and siltstone. The average annual temperature is about 54 degrees F., and average annual precipitation is about 45 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cynthiana, Lowell, Fairmount, Faywood, and Lowell, Maury, Salvisa and Shelbyville series. Cynthiana, Faywood, Lowell, Maury and Salvisa soils do not have mollic epipedons. Shelbyville soils are fine-silty. Cynthiana and Fairmount soils are shallow. Faywood and Salvisa soils are moderately deep.

DRAINAGE AND PERMEABILITY: Well drained with moderately slow permeability. Runoff is medium on slopes less than 5 percent and high on slopes greater than 5 percent.

USE AND VEGETATION: Nearly all areas are used for growing hay, corn, tobacco, and small grains or as pasture. Native vegetation is chiefly hardwoods interspersed with grassy glades. The dominant tree species are oaks, black walnut, hickory, ash, hackberry, elm and maple.

DISTRIBUTION AND EXTENT: The Bluegrass region of Kentucky and possibly southwestern Ohio. Total extent probably is moderate.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Morgantown, West Virginia

SERIES ESTABLISHED: Madison County, Kentucky; 1968.

National Cooperative Soil Survey
U.S.A.

Reference 13

MADISON'S HERITAGE ONLINE

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MADISON'S HERITAGE (ICE CO.)

Title

Madison's Heritage (Ice Co.)

Description

Before the invention of the electric refrigerator the people of Richmond and Madison County were able to have ice for summer use only through a rather difficult process.

In the coldest part of winter when the ice would form in a thick layer on ponds and lakes the people would use saws to cut the ice into blocks which were then carried to a special "icehouse" built in the ground nearby. Not only were the blocks heavy but the work of sawing them out was dangerous for those who walked on the ice. There also was serious concern about the purity of the ice since some germs in the water could survive the freezing. Typhoid fever especially was feared.

Although there were several attempts at operating small icemaking machines in the late 1800's, large scale ice manufacturing did not appear here until 1905, when the Richmond Ice Company was organized. The present ice plant building is the original one, built to the dimensions of 152 by 84 feet. A large amount of high quality machinery was installed and the small lake was made in order for the plant to have its own water supply. A cold storage section was also erected.

In 1910 the company officers were H.B. Hanger, president; L.B. Weisenburg, secretary-treasurer; W.B. Craven superintendent, and John S. Conway manager.

In an effort to produce pure ice the water was distilled twice at a temperature considerably above 212and then filtered three times. Forty tons of this pure ice could be made each day.

A railroad spur was built so that cars of both the L&N and the L&A (the new name of the RINB Railroad) could be loaded directly from the building. The L&N found the Richmond plant quite handy for it was the only such ice plant on the railroad between Cincinnati and Atlanta.

In the early days of the company enclosed horse-drawn wagons were used for local delivery. By the 1930's, specially built open wagons were drawn through the streets of the city with the large blocks of ice covered by tarpaulins. Housewives were supplied with cards with the large numbers, 25, 50, 75 and 100, in different positions to be displayed on the front porch so that the driver could tell by a glance from the street which home needed how much ice that day. After a block of the proper size was chipped off the iceman would throw on his rubber apron over his back and, using his ice tongs, carry the block to the back door of the house. There he would put it in the big oaken icebox.

Those of us who grew up in Richmond in the 1930's can remember a lot of happy moments on hot summer days when we would run after the slowly moving ice wagon and jump on the tailgate to grab a deliciously cold fresh chip.

Creator

Dr. Robert Grise

Date

2/10/1971

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1971 Articles

Tags

businesses, history, transportation

Citation

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Reference 14

Popular Science Monthly/Volume 39/May 1891/Ice-Making and Machine Refrigeration

< Popular Science Monthly | Volume 39 | May 1891

ICE-MAKING AND MACHINE REFRIGERATION.

BY FREDERIK A. FERNALD.

THE manufacture of ice now bids fair to become a regular industry in temperate as well as in tropical climates. Pioneer work in this field was done more than sixty years ago, but it is only within the last ten years that the groping attempts of the early inventors have developed into processes sufficiently economical to make the artificial production of ice a commercial success. Artificial ice has been made in tropical countries and in our Southern cities for many years, but the industry has been greatly extended in this country by the two successive mild winters of 1888-'89 and 1889-'90. It has now gained a foothold even in our Northern States, while in the South comparatively small towns have their ice factories.

The scientific fact on which the making of artificial ice depends is that when a liquid evaporates it uses up a great deal of heat, which it draws from anything that happens to be around it. If a can of water is at hand, its temperature is reduced, and if the action goes far enough the water will be frozen. This cooling action can be felt by pouring a little ether or alcohol upon the hand. The liquid evaporates rapidly, and the loss of the heat which it takes up cools the hand very perceptibly. If a bottle containing water is kept wet on the outside with ether, the evaporation will chill the water and eventually freeze it. This is essentially the process by which the *carafes frappées* of French restaurants are produced. The decanters filled with fresh water are set in shallow tanks containing brine, which remains liquid below the temperature at which fresh water freezes. In contact with these tanks are receivers, which can be kept charged with newly formed ether vapor. The chilling vapor cools the brine, and this in turn takes heat from the water in the decanters, which soon freezes.

In making ice on the large scale, either ammonia or sulphurous oxide is used instead of ether, because these substances are cheaper and are not inflammable. Ammonia is a gas or vapor at ordinary temperatures. What is commonly called ammonia, or, more properly, ammonia water, is water with several hundred times its volume of this gas dissolved in it. For ice-making, anhydrous ammonia—that is, ammonia perfectly free from water—is used. The first thing to do is to get the ammonia into the liquid form. There are two ways of condensing a vapor to a liquid—by cold and by pressure. Practically it can be done easiest by combining the two. The ammonia gas is subjected to pressure, and forced through a coil of pipe called a condenser, where it is cooled by water from any convenient supply running down over the pipes. By this means the latent heat in the gas is pressed out, and is taken up and carried away by the water. After being liquefied in the condenser the ammonia is forced into pipes larger than the liquid can fill, where it immediately expands into a vapor and exerts its chilling effect.

Two methods of making ice, which differ, however, in only one step of the process, are now in use. In a factory established last year in New York city, which the writer has been permitted to go through, the "compression system" is used, with anhydrous ammonia as the cooling agent. The machinery employed consists of a powerful pump driven by steam, with which is connected the necessary condensers, piping, etc. Liquid ammonia is supplied by the makers of ice machines in strong iron drums. The ammonia is run into a cylindrical iron tank, from which it is allowed to pass through a small orifice into the coils of pipe in the freezing tank. In this factory the freezing tanks are of iron, about twenty by fifty feet in size, and four feet deep. Over them is a floor, which is cut up into rows and lines of rectangular covers. Each of these lifts up, showing a can under it, twenty-two by eleven inches in size, and forty-four inches deep. The tank contains a brine of regulated strength, and the cans when filled with the water to be frozen float in this brine, coming within an inch or two of the bottom of the tank. Back and forth across the

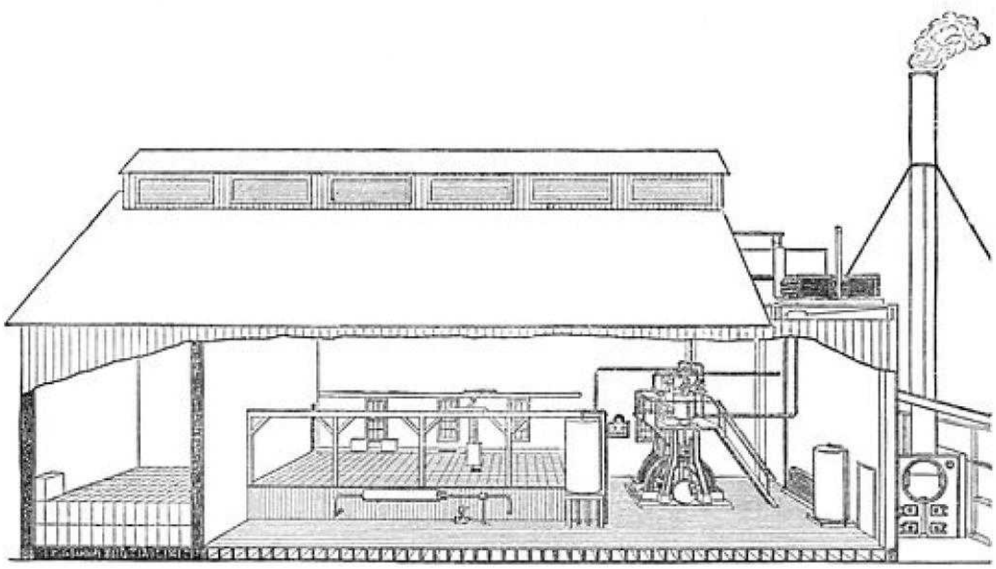


FIG. 1.—INTERIOR OF AN ICE FACTORY.

tank, between the rows of cans, run the coils of pipe through which the ammonia passes. The evaporation of the ammonia constantly going on within this system of pipes cools the brine down to 15° or 18° Fahr. In order to equalize the temperature in all parts of the tank the brine is kept in constant circulation by a revolving agitator, which resembles a propeller-screw. Surrounded by this frigid liquid the water in the cans becomes congealed to uniform hard blocks of ice, weighing about three hundred and twenty pounds each. A tank of the dimensions above given contains five hundred cans. About sixty hours are required for the freezing process.

In Fig. 1 the tank, with its flooring, is shown in the middle of the building. To the right of this is the pump, and at the extreme right is the boiler-room. Over the tank is a traveling crane, by which the cans containing the ice are lifted out and conveyed to one end of the room. The crane consists of a beam, with a pair of wheels under each end, which travel on tracks six or seven feet above the floor. By means of the tackle hung from this beam a man raises a can of ice above the floor, and then pushes the crane with its load to the end of the room. Here the can is put into a sort of swinging box and tilted over into a slanting position, mouth downward. Tepid water is then allowed to run over the can from a line of small jets on each side. In two or three minutes the block of ice is melted free from the can and slides through a shute into the ice-house. The box is an automatic contrivance, and, as soon as the ice has left it, it reverses, turning the can upright and shutting off the water. In some factories the can is dipped into a tank of warm water to loosen the ice. In the figure, a can is seen suspended from the crane; at the back, under the middle window, is the small tank of warm water for dipping the cans;

and in front of the next window two blocks of ice are lying. The room at the left is the ice-house. It has double walls packed with non-conducting material, and is shown with two layers of blocks in it.

The ammonia gas, after passing through the coils of pipe in the freezing tank, is drawn through a pipe into the great pump, where by the return stroke of the piston it is compressed and forced out through another pipe into the condenser. In Fig. 2 the condenser is shown in an upper room. It consists of several coils of pipe, over which cold water is kept running. The small pipes which run down obliquely from the ends of the coils are to carry away the ammonia as it becomes liquefied into the storage tank, which is the horizontal cylinder on the floor with the condenser. From the storage tank the ammonia, still under pressure, passes down into one of the large vertical cylinders shown in the lower part of the figure, and from this it goes into the expansion coils in the freezing tank, and passes again through the cycle of operations just described. The same ammonia is thus used over indefinitely. The pressure to which the ammonia is subjected in this apparatus ranges from one hundred and twenty-five to one hundred and seventy-five pounds per square inch. The pump, shown in the lower part of Fig. 2, is one of several makes. It has two compression cylinders, seen at the top of the tall A-shaped frame. The piston-rods work vertically beneath these cylinders, and are connected by cranks and connecting-rods to the piston working in the steam-cylinder seen at the right. The use of the ammonia in making ice can be compared to the use of a sponge in baling a boat. As the sponge soaks up water from the bottom of the boat, and after being squeezed over the side is ready to soak up more, so the ammonia soaks up, as it were, heat from the water to be frozen; and, after this has been squeezed out by the compressor, the liquid is ready to take up more heat.

The water from which the ice is made in the New York factory, previously mentioned, is from the city supply (Croton). Before being frozen it is purified by filtering and distillation. It is first filtered, then converted into steam in vertical boilers about twenty feet high; the steam is condensed and again filtered in steam filters filled with coke. The condensation is effected by placing the filters in the open air on the roof of one of the buildings, and circulating around them water pumped from the river, near which the factory is located. After leaving the steam filters and condensers, the water is further cooled by passing through a cooler similar to the condenser used for the ammonia. After leaving the cooler, the water is filtered through charcoal, and is then ready to go into the cans. It is filled into them through a hose, which ends in a long nozzle, containing a patented device that prevents air from being carried down into the water. In order to make clear ice, the formation of air-bubbles in it must be prevented. Water always contains some air, which is driven out by boiling. When boiled water is frozen, the ice contains only what little air is absorbed by the water while it is being cooled down to the freezing-point. The artificial ice, therefore, is clear except a thin layer running lengthwise through the middle of the cake—the part that freezes last. A very attractive exhibit for a market is made by putting meat, fish, fruit, and flowers into cans of water and freezing them into the clear ice. Articles having smooth surfaces, and consequently few crevices in which air-bubbles can cling, give the best results.

It was mentioned early in this article that sulphurous oxide is used as a cooling agent in making ice. This is the choking gas that is formed when sulphur burns. An ice machine employing anhydrous sulphurous oxide is made, which, as it works

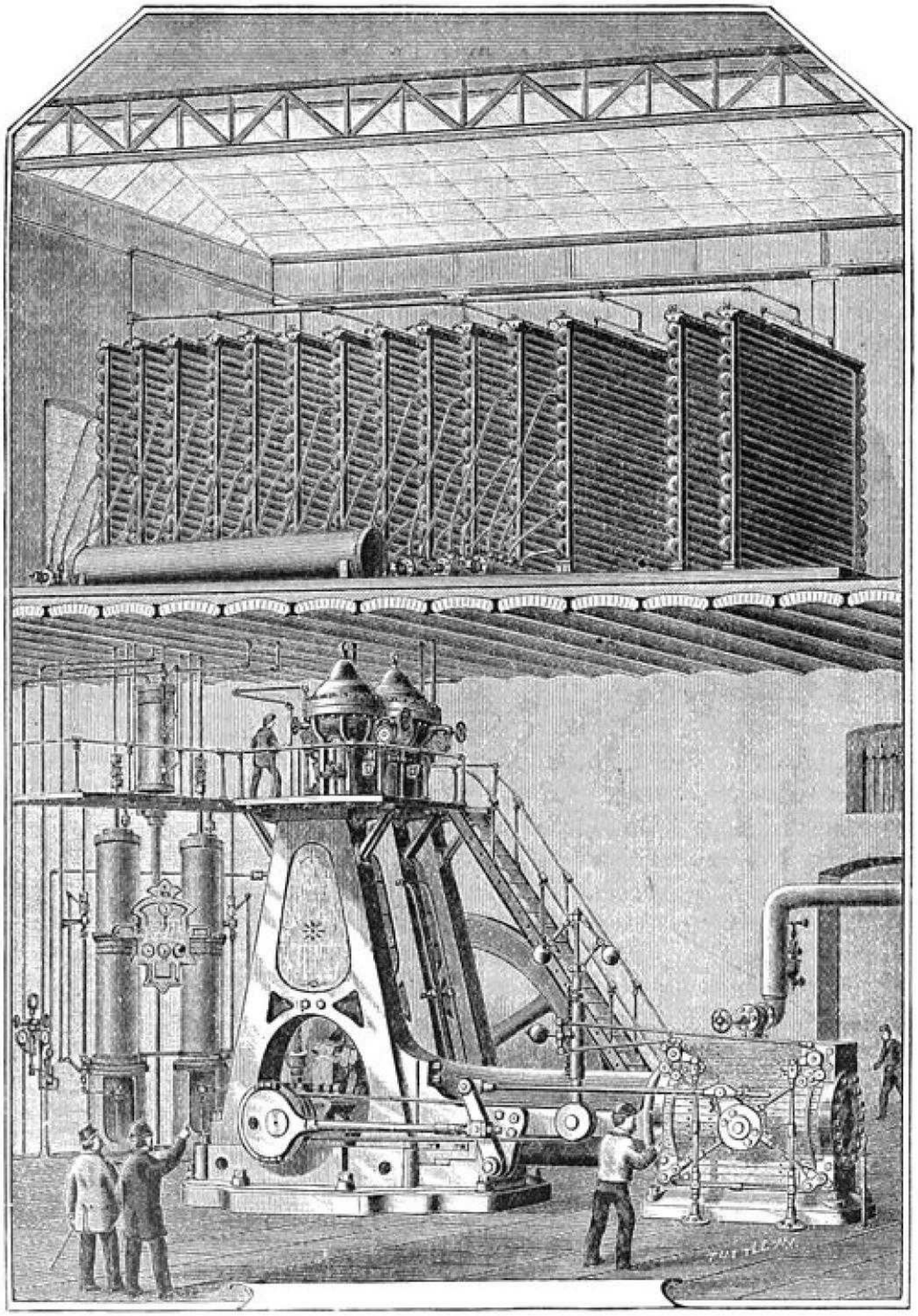


FIG. 2.—AN AMMONIA-COMPRESSION ICE MACHINE.

according to the "compression system," like the ammonia machine just described, necessarily has the same essential parts, though differing somewhat in form and arrangement. It uses a brine made from magnesium chloride instead of common salt.

There is also a class of ammonia machines, that operate on what is called the "absorption system." In these machines the operation starts with ammonia water instead of anhydrous ammonia. The liquid is heated in a boiler, and a mixture of about nine parts ammonia gas and one part steam is driven off from it. The mixed vapors pass first into a rectifier, where most of the steam is condensed to water, which runs back into the boiler. The temperature in the rectifier is not low enough to condense the ammonia, which passes on, now nearly free from water, into the condenser. Here it is liquefied by the joint action of cold and pressure, only the pressure is not supplied by mechanical means, but by the expansive force of the stream of vapor that is constantly being driven out of the boiler. The liquid ammonia next passes into the expansion coils in the freezing tank, just as in the compression system. After doing its work the gas is led into an "absorber," which is very similar to the condensers already described. Here it is reabsorbed by the water that it was originally driven out of, this water ("poor liquor" it is called) having been forced out of the boiler by the pressure prevailing in it and cooled for the purpose. It is this operation that gives the name to the absorption system. The resulting solution of ammonia is returned to the boiler by a pump and begins again the same round of operations.

In hot climates natural ice is an expensive luxury, as it must be brought long distances, and suffers much loss from melting. In those regions the artificial product has a great advantage in respect to cost. Even where there is usually a cold winter, as in the northern United States, a failure of the ice-crop sometimes occurs in the fields usually depended upon, followed by a more or less necessary increase in price the following summer. Ice machines have now reached such a high degree of efficiency that their product can compete with natural ice in these latitudes. In the summer of 1890 the price of natural ice to families in New York was a dollar a hundred-weight, while artificial ice sold for fifty cents. No doubt further improvements in machinery and methods will be invented, which will make it possible to furnish ice at a still lower price than now, and will lead to a freer and more general use of this commodity. Not only can artificial ice be sold at a lower price than the natural in most markets, but it is more economical, for the reason that it does not melt so fast. This is because it is frozen without the interruptions that allow layers of bubbles to collect under natural ice formed on still water, and it contains no soft snow-ice. It is, therefore, more compact than any but the very best of the natural product.

Another advantage that is claimed for artificial ice is, that when made from distilled water it is free from the impurities that natural ice sometimes contains. Nearly all natural water contains considerable numbers of bacteria, many of which are derived from the sewage discharged into some lakes and rivers from which ice is cut. It is commonly believed that water in

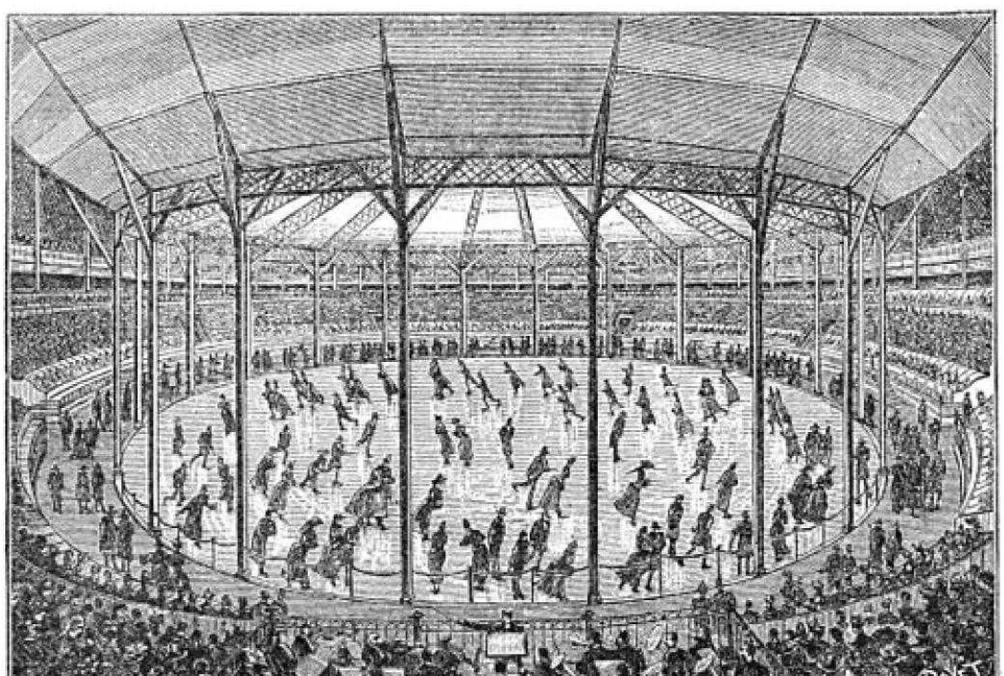


FIG. 3.—RINK OF ARTIFICAL ICE IN PARIS.

freezing purines itself from all kinds of contamination, but Dr. T. M. Prudden has shown in this magazine that the truth is otherwise. In his article on Our Ice-supply and its Dangers (Popular Science Monthly for March, 1888) he says:

A great deal of careful experiment has shown that water in freezing largely expels its coarser visible contaminations, and also that a large proportion of the invisible bacteria which it contains may be destroyed, even as many as ninety per cent. But still large numbers may remain alive, for many species are quite invulnerable to the action of cold. It has been found that in ice formed from water containing many bacteria, such as water with sewage contamination, the snow-ice almost invariably contains many more living bacteria than the more solid, transparent part; so that the snow layer should be especially avoided in ice obtained from questionable sources. Unfortunately, the bacteria which cause typhoid fever are not readily killed by cold, and may remain alive for months, fast frozen in a block of ice.

As the neighborhood of our ice-fields becomes more thickly-settled, and the demand for ice also increases, the danger that frozen filth will be served out to consumers of ice will increase likewise. It is fortunate that the artificial process stands ready to shield us from this peril.

Utility has not entirely monopolized the artificial production of ice; it has been made to serve sport as well. About 1875 a Mr. Gamgee, in England, constructed a rink of artificial ice for summer skating, and several others have been made in that country. In 1889 an immense rink of this kind was established in Paris, circular in form and one hundred and seventy feet in diameter. Around the sheet of ice was a promenade over seven yards wide,

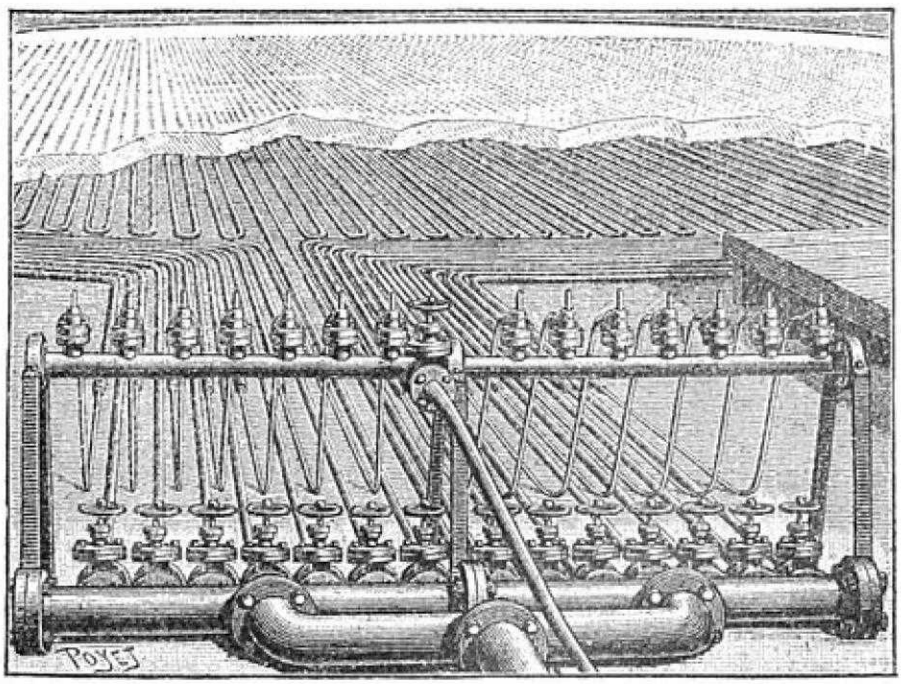


FIG. 4.—ARRANGEMENT OF THE EXPANSION COILS IN A RINK IN PARIS.

and outside of this were placed seats for spectators, a band-stand, etc., the whole being covered by an arched roof. The arrangement of this rink is shown in Fig. 3. The ice-sheet was formed on a concrete bed, upon which lay an immense coil of iron pipe, as shown in Fig. 4, having a total length of ten miles. The pipe was of an inch and a quarter internal diameter, and the lengths were placed five inches apart. Through this coil the ammonia circulated, the absorption system being used to effect the congelation.

The machines with which ice is made have also another and up to the present time a larger application. This is the production of cold in breweries, abattoirs, markets, and cold storage

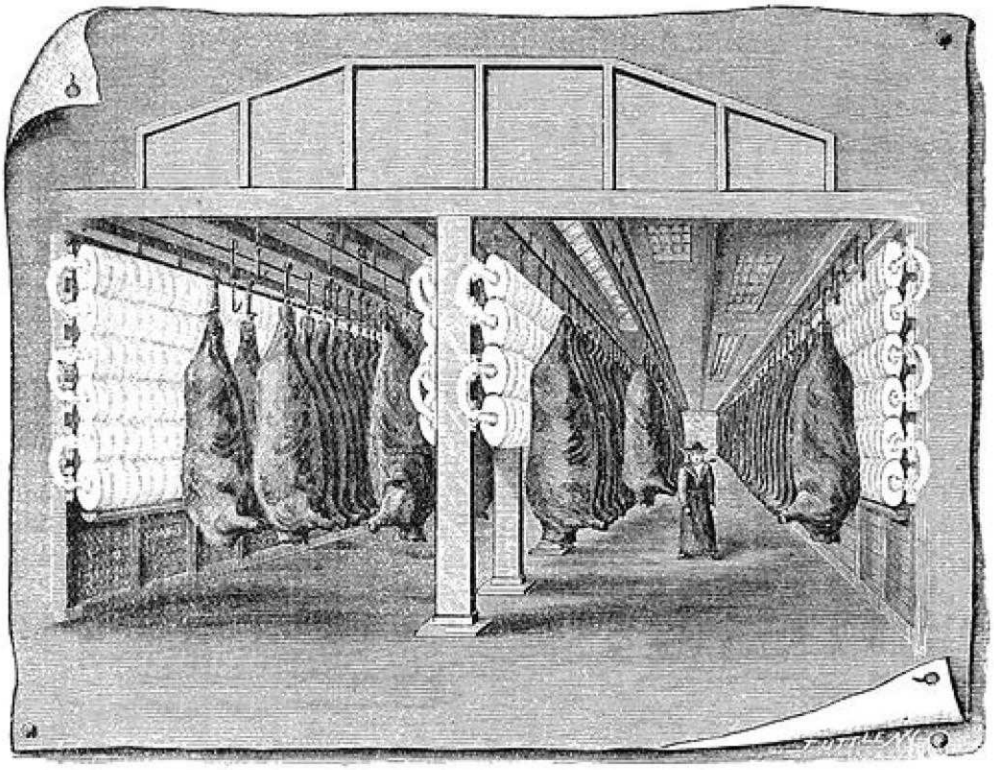


FIG 5.—A ROOM IN A COLD STORAGE WAREHOUSE.

houses. The fermentation of beer must take place at quite a low temperature, which must be steadily maintained; hence energetic and continuous cooling of the wort has to be provided for. The brewers were formerly among the largest customers of the ice companies, but now nearly every brewery has a refrigerating machine of its own, and more machines are used by them than by all other users put together. No ice is made with these machines, except for packing beer for shipment, as the cooling required can be accomplished more conveniently by circulating cold brine or cold fresh water in pipes where it is needed.

The system of cold storage which has sprung up within the past few years has been made possible by this same process. Immense quantities of meat and other perishable provisions are now kept in great warehouses until wanted, thus insuring a steady supply to the consumers in our large cities. The provisions, when brought into these buildings, have the temperature prevailing outside, and warm the air that comes in contact with them. This air rises into a loft, where it comes in contact with pipes containing cold brine, becomes chilled, and descends through flues to the room below, entering it near the floor. This circulation goes on until the provisions have been cooled down to the temperature of the room. The air may be cooled, also, without the use of brine, by letting it come in contact with the coils in which the ammonia expands. Air has also been used direct for the production of cold by compressing it. Like condensed ammonia, it takes up much heat in expanding to its ordinary volume, but this system is not economical. In Fig. 5 a somewhat different arrangement is represented. Where there is not space for the loft, the expansion coils may be placed in the same room with the provisions. Before refrigerating machines came into use, refrigeration on the large scale had been tried with ice, and had failed. This was owing to the dampness imparted to the air by the melting ice. The brine or ammonia coils not only do not add any moisture to the air, but even withdraw a great deal that it naturally contains. This moisture becomes condensed on the pipes as the air circulates around them, and makes itself visible as a gleaming white coating of hoar-frost. On board steamers, machines are employed both to preserve dressed meat and to prevent live cattle transported through tropical regions from dying of the heat in their confined quarters. Machines of moderate size also find application in hotels—two of the recently built houses in New York have them—in dairies, chocolate factories, and they are used also in making stearin and margarin, in rectifying alcohol, extracting paraffin from petroleum, etc. A machine of the size represented in Fig. 2 will produce a refrigerating effect equal to that obtained by the consumption of two hundred and twenty tons of ice a day, or it will make one hundred and thirty tons of solid ice daily. The company that makes this style of machine is now building one of three hundred tons refrigerating capacity, which will be the largest in the world. But that is soon to be exceeded, as the contract is already made for a five-hundred-ton refrigerating machine.

Artificial refrigeration has also been applied to sinking shafts and driving tunnels through quicksand and loose wet gravel. These materials wash into an excavation as fast as they are removed, and in many cases progress through them is next to impossible by ordinary methods. The difficulty is overcome by freezing the loose soil around or in front of the work. This process was first used by a German mining engineer in 1883. In sinking a shaft, pipes of about eight inches diameter are driven down in a ring around the place of the proposed excavation. A brine, cooled to within a few degrees of 0° (Fahr.), is sent down through an inner pipe and returns through the space between the two pipes. By this means a cylinder of the wet earth is frozen, within which the digging is done and the lining of the shaft put in place. The core of the cylinder which is to be removed will be partly or wholly frozen, according to the degree of refrigeration employed. Frozen quicksand looks like a fine-grained sandstone, and is about as hard to cut through.

Those who are acquainted with the history of invention, will not be surprised to learn that the Asiatics were centuries ahead of us in the making of ice, as in the use of gunpowder, the compass, etc. Ice has long been made in India by the following method: Pits two feet deep and twenty or thirty feet square are dug in a large, open field, and about half filled with straw. After sunset shallow dishes of porous clay are placed on the straw and water is poured into them. The rapid evaporation of part of the water, assisted by the radiation of heat from the straw, chills the water remaining, and, if the night is favorable, thin sheets of ice form in the pans by morning. The operation is most successful when the sky is clear and a gentle dry breeze is blowing. Although we of the Western world have clearly been anticipated in producing ice artificially, we may still claim the superior credit that our process has not remained stagnant for generations, but has achieved many of the possibilities that have been open to it, and become independent of such limitations as the state of the weather, and others that hamper the operations of the "gentle Hindoo."For the electrotypes of Figs. 2 and 5 in this article I am indebted to the courtesy of the De La Vergne Refrigerating Machine Company.

Reference 15

RICHMOND'S QUALITY WATER REPORT

INFORMATION ABOUT YOUR DRINKING WATER

PWSID# KY0760370

BILLING INFO 859-623-2323

RICHMOND UTILITIES
P.O. BOX 700
300 HALLIE IRVINE STREET
RICHMOND, KY 40475

Richmond Utilities consistently strives to produce water of high quality. We are pleased to report that we have not had any violations of a contaminant level. This brochure is a summary of the quality of water provided to our customers last year (2015). It is also a record reflecting the hard work by our employees to continue to produce water which is equal to or better than state and federal regulations for drinking water.

Included in this report are the details of where your water comes from, what it contains, and how it compares to the standards set by regulatory agencies. Richmond Utilities is committed to providing you with information about your water, because customers who are well informed are our best allies in supporting improvements necessary to maintain the highest drinking water standards.

We work around the clock to provide top quality water to every tap. We ask all our customers to protect our water sources, which are the heart of our community and our children's future.

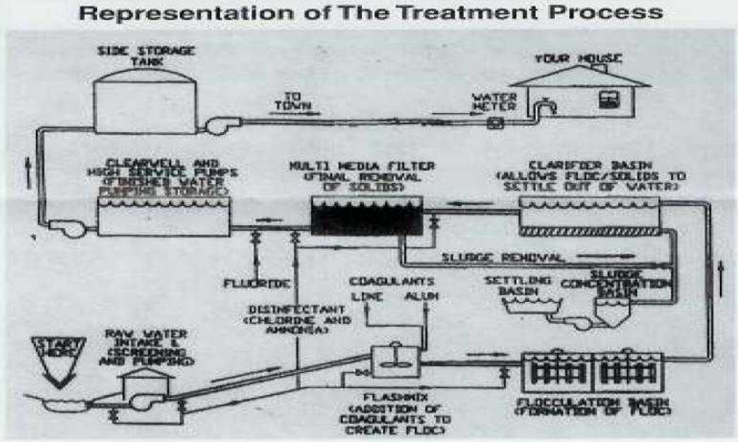
Water Process Improvements in 2015

1. **Installed backup power at water storage facility**
2. **Installed underground electrical service at water plant**
3. **Replaced 500 feet of 4 inch water line on West Walnut**

Plans for 2016

1. **Update distribution telemetry sytem**
2. **Replace 1000 feet of 6 inch line on Four Mile**
3. **Replace 4 inch line with 6 inch line on 1st Street from Main St to Water St**
4. **Replace 6 inch Westover line with 8 inch line**

Representation of The Treatment Process



En Español

Este folleto le muestra como que Richmond Utilities continua proveyéndolo a usted de un servicio de agua segura y confiable. Si tiene usted preguntas acerca de la calidad del agua, llame a Lonnie Banks, al teléfono 858-623-2323 durante las horas regulares de oficina.

Sources of Richmond's Drinking Water

Our source water is the Kentucky River. It is a surface water source. Sources of drinking water, both tap and bottled water, include rivers, lakes, streams, ponds, reservoirs, springs and wells. As water travels over the land's surface or through the ground, it dissolves naturally occurring minerals and radioactive material, and can be polluted by animals or human activity. Several contaminants that may be found in untreated source water include: biological contaminants (such as viruses and bacteria, that may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife); inorganic contaminants (such as salts and metal, that can be naturally-occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming); pesticides and herbicides (which may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses); organic chemicals (including synthetic and volatile organic chemicals, which are byproducts of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, and septic systems); and radioactive materials (which can be naturally-occurring or be the result of oil and gas production and mining activities).

To ensure that tap water is safe to drink, the Environmental Protection Agency (EPA) prescribes regulations that limit the amount of certain contaminants in water provided by public water systems. The Food and Drug Administration regulations establish limits in bottled water that shall provide the same protection for public health.

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the U.S. Environmental Protection Agency's Safe Drinking Water Hotline at 1-800-426-4791.

The Safe Drinking Water Act Amendments of 1996 require every water system to prepare a source water assessment that addresses the system's susceptibility to potential sources of contamination. This study indicates that our susceptibility is generally moderate. Forested areas comprise 3% or more of the land areas within this zone. Logging within these areas could result in soil erosion, and therefore non-point source pollution, if Best Management Practices (BMP) are not carefully followed. Similarly, areas of row crops pose a potential threat to Richmond's intake, as tillage, the application of pesticides, and the application of fertilizers could become non-point-source pollutants if BMP's are not carefully followed. Two bridges, a segment of the CSX railroad, areas of row crops, and an active Superfund Site also occur within close proximity to the water source. Other potential contaminant sources within Richmond's Zone of Potential Impact include major roads, sewer lines, abandoned and non-permitted oil and gas wells, Superfund sites and pasturelands. The plan is available for review during regular business hours at the Richmond Utilities Office at 300 Hallie Irvine Street.

Special Info Available: *"Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons-such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their healthcare providers. Environmental Protection Agency and Centers for Disease Control guidelines on appropriate means to lessen the risk of infection by Cryptosporidium and other microbial contaminants are available from the EPA's Safe Drinking Water Hotline (800-426-4791)."*

For questions about the quality of our drinking water, or of this report, contact Lonnie Banks at the water office. The telephone number is (859) 623-2323. Our board meetings are also open to the public, and we welcome your comments. The meetings normally take place on the 4th Wednesday of each month at 8:30 A.M. These meeting are held at our Utility Office located at 300 Hallie Irvine Street.

TREATED WATER QUALITY SUMMARY

Detected Substance (Date)	Highest Level Detected (Range of Detection)	Highest Level Allowed (EPA's MCL)[1]	Ideal Goals (EPA's MCLG)[2]	Sources of Contaminants
Regulated at Treatment Plant				
Gross Alpha (1/5/11)	0.4 pCi/L (0-0.4)	15 pCi/L	0 pCi/L	Erosion of Natural Deposits
Barium (4/7/15)	0.023 ppm (NA)	2 ppm	2 ppm	Erosion of Natural Deposits
Fluoride (4/15)	0.7 ppm	4 ppm	4 ppm	Natural Geology/Sediment
Nitrate (10/21/15)	0.3 ppm (NA)	10 ppm	10 ppm	Erosion of Natural Deposits
Combined Radium (1/5/11) (measured as Radium 228)	0.3 pCi/L (0-0.3)	5 pCi/L	0 pCi/L	Erosion of Natural Deposits
Regulated at Customer's Tap				
Copper (8/13)	0.221 ppm (0.073-90th percentile)	1.3 ppm (Action Level[5])	1.3 ppm	Consumer plumbing & Service connection
Lead (8/13)	4ppb (0-90th percentile)	15 ppb (Action Level)	0 ppb	Consumer plumbing & Service Connection
Regulated in the Distribution System				
Total Trihalomethanes	58ppb avg (6-97)	80 ppb	0 ppb	Disinfection interaction
Haloacetic Acids	47 ppb avg (5-70)	60 ppb	0 ppb	Disinfection interaction
Chlorine/Chloramine	1.22ppm avg (0.73-1.6)	MRDL[3] = 4.0 mg/L	MRDLG[4] =4.0 mg/L	Added to control microbes

Particulate Test Results

Detected Substance (Date)	Highest Level Detected (Range of Detection)	Highest Level Allowed (EPA's MCL)	Ideal Goals (EPA's MCLG)	Sources of Contaminants
Turbidity (6/13/15)	0.13 NTU (≤.13 100%)	Treatment Technique[6]	None	Natural River Sediment
Total Organic Carbon	1.27ratio avg (0.89-1.67)	Treatment Technique[6]	None	Natural River Sediment

≤.13 100 % indicates that 100 % of the time, the produced water was at or below the maximum allowable level for turbidity. Turbidity has no health effects, but it is used to monitor the effectiveness of the treatment process. However, turbidity can interfere with disinfection and provide an environment for microbial growth. The allowable level is < (less than) .3 NTU 95% of the time or no more than 1 NTU in any representable sample. The test unit NTU actually is a measurement of the clarity of the water. A turbidity value of 5 NTU would be just slightly cloudy in appearance.

The treatment technique for Total Organic Carbon (TOC) is based on the lowest running average for the monthly ratios of the % TOC removal required. A minimum ratio of 1.00 is required to meet this treatment technique. We are pleased to note that we did achieve this removal rate.

Listed above are the contaminants detected in Richmond's drinking water during 2015 or as otherwise noted. Samples for total coliform are monitored on a monthly basis. There were no total coliform positive samples in 2015. NOT LISTED are the non-detected values of the other contaminants monitored for in 2015. The results of all monitoring performed are available at the water office. Our source water has been tested for Cryptosporidium and one Cryptosporidium was found to be present.

DEFINITIONS:

[1]Maximum Contaminant Level (MCL)
"The highest level of contaminant that is allowed in drinking water. MCL's are set as close to the MCLG's as feasible using the best available treatment technology.

[2]Maximum Contaminant Level Goal (MCLG)
"The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLG's allow for a margin of safety."

[3]Maximum Residual Disinfectant Level (MRDL)
"The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants."

[4]Maximum Residual Disinfectant Level Goal (MRDLG)
"The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants."

[5]Action Level-The concentration of a contaminant which, if exceeded,, triggers treatment or other requirements that a water system must follow.

[6]Treatment Technique- A required process intended to reduce the level of a contaminant in drinking water.

EPA-Environmental Protection Agency

NA-indicates that only one test was performed . A range does not apply.

ND- Not detected. Result was below instrument detection limit.

Pci/l- a measure of radioactivity

NTU- Standard turbidity unit

ppm- part per million (equivalent to one minute in 2 years).

ppb- part per billion (equivalent to one minute in 2000 years).

Ratio- For TOC's, this is obtained by dividing the TOC of the untreated water by the TOC of the treated water.

Lead and Copper values are based on the 90th percentile of monitoring results. We are please to report that no sample result exceeded the action level.

Information About Lead: If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. Your local public water system is responsible for providing high quality drinking water, but can not control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

What is Cryptosporidium?

Cryptosporidium is a microbial pathogen found in surface water throughout the United States. Although filtration removes Cryptosporidium, the most commonly used filtration methods cannot guarantee 100 percent removal.

Ingestion of Cryptosporidium may cause cryptosporidiosis, an abdominal infection. Symptoms of infection include nausea, diarrhea and abdominal cramps. Most healthy individuals can overcome the disease within a few weeks.

People with severely weakened immune systems have a risk of developing life-threatening illness. We encourage such individuals to consult their doctor regarding appropriate precautions to take to avoid infection.

Cryptosporidium must be ingested to cause disease, and it may be spread through means other than drinking water.

The U.S. EPA issued a rule in January 2006 that requires systems with higher Cryptosporidium levels in their source water to provide additional treatment. To comply with this rule, Richmond Utilities conducted 24 consecutive months of monitoring for Cryptosporidium in our raw water sources. We detected the no Cryptosporidium organisms in the Kentucky River during that testing, but we did have a detect of 1 organism in July 2015. Based on the results of our Cryptosporidium monitoring, no additional treatment will be required by the U.S. EPA regulation.

Health Effects

Turbidity. Turbidity has no health effects. However, turbidity can interfere with disinfection and provide a medium for microbial growth. Turbidity may indicate the presence of disease-causing organisms. These organisms include bacteria, viruses, and parasites that can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.

Haloacetic acids, or HAA. Some people who drink water containing haloacetic acids in excess of the MCL over many years may have an increased risk of getting cancer.

TTHMs [Total Trihalomethanes]. Some people who drink water containing trihalomethanes in excess of the MCL over many years may experience problems with their liver, kidneys, or central nervous systems, and may have an increased risk of getting cancer.

Chlorine. Some people who use water containing chlorine well in excess of the MRDL could experience irritating effects to their eyes and nose. Some people who drink water containing chlorine well in excess of the MRDL could experience stomach discomfort.

Total organic carbon. Total organic carbon (TOC) has no health effects. However, total organic carbon, provides a medium for the formation of disinfection byproducts. These byproducts include trihalomethanes, or THMs, and haloacetic acids, or HAAs. Drinking water containing these byproducts in excess of the MCL may lead to adverse health effects, liver or kidney problems, or nervous system effects, and may lead to an increased risk of getting cancer.

Beta/photon emitters. Certain minerals are radioactive and may emit forms of radiation known as photons and beta radiation. Some people who drink water containing beta particle and photon radioactivity in excess of the MCL over many years may have an increased risk of getting cancer.

Alpha emitters. Certain minerals are radioactive and may emit a form of radiation known as alpha radiation. Some people who drink water containing alpha emitters in excess of the MCL over many years may have an increased risk of getting cancer.

Combined Radium 226/228. Some people who drink water containing radium 226 or 228 in excess of the MCL over many years may have an increased risk of getting cancer.

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF WATER

Recognizes

Richmond Utilities
KY0760370

For meeting the Area-Wide Optimization Program goals for both settled and filtered water in 2015 and being considered an optimized plant for turbidity / microbial removal

AREA WIDE OPTIMIZATION PROGRAM

AWOP

Branch Manager, Compliance and Technical Assistance

Director, Division of Water

Reference 16

RAINFALL FREQUENCY VALUES FOR KENTUCKY

Engineering Memorandum No. 2

April 30, 1971; Revised - June 1, 1979

COMMONWEALTH OF KENTUCKY

DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION

BUREAU OF NATURAL RESOURCES

DIVISION OF WATER RESOURCES

KENTUCKY

DIVISION OF WATER RESOURCES
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO. 2 (4-30-71), REVISED (6-1-79)

RAINFALL FREQUENCY VALUES FOR KENTUCKY

THIS INFORMATION HAS BEEN PREPARED BY THE DIVISION OF WATER RESOURCES, DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION, COMMONWEALTH OF KENTUCKY. (AUTHORITY-KRS 151.220)

POINT RAINFALL VALUES HAVE BEEN DETERMINED FOR EACH OF THE 120 COUNTIES OF THE COMMONWEALTH AND TABULATED IN A CONVENIENT FORM. THE SOURCES OF THE INFORATION WERE TECHNICAL PAPER 40 (RAINFALL FREQUENCY ATLAS OF THE UNITED STATES FOR DURATIONS FROM 30 MINUTES TO 24 HOURS AND RETURN PERIODS FROM 1 TO 100 YEARS) AND TECHNICAL PAPER 49 (TWO-TO TEN-DAY PRECIPITATION FOR RETURN PERIODS OF 2 TO 100 YEARS IN THE CONTIGUOUS UNITED STATES), WEATHER BUREAU, U.S. DEPARTMENT OF COMMERCE. PRECIPITATION VALUES PUBLISHED IN HYDROMETEOROLOGICAL OF THE ARMY, JUNE, 1978).

THE ESTIMATED POINT RAINFALL VALUES ARE BELIEVED TO BE ADEQUATE FOR MOST ENGINEERING DESIGN PURPOSES AND ARE MADE AVAILABLE TO FILL THE NEEDS OF PERSONS WHO DO NOT HAVE THE BASIC INFORMATION READILY AVAILABLE. THE POINT RAINFALL VALUES USED IN THIS PUBLICATION ARE VALUES FOR TEN (10) SQUARE MILE AREAS.

ADJUSTMENT FOR APEAL AND SEASONAL VARIATIONS ARE NOT COVERED IN THIS PUBLICATION, HOWEVER ASSISTANCE FOR THE MORE SOPHISTICATED DETERMINATIONS MAY BE OBTAINED BY CONTACTING THE DIVISION OF WATER RESOURCES.

THE LAST SERIES OF TABLES SHOWS VALUES FOR RUNOFF VOLUMES AND QUICK RETURN FLOWS. THE RUNOFF VOLUMES REPRESENT VALUES WHERE MEASURED RUNOFF MAY VARY FROM THAT OBTAINED BY THE CURVE NUMBER METHOD. THEY REPRESENT REGIONALIZED VALUES DERIVED FROM GAGED STREAMFLOW DATA AND SUPPLEMENTED WITH CLIMATOLOGICAL DATA AND LOCAL OBSERVATIONS. THE QUICK RETURN FLOWS ARE THOSE RATES OF DISCHARGE EXPECTED TO PERSIST BEYOND THE FLOOD PERIOD AS DESCRIBED BY THE 10-DAY PRINCIPAL SPILLWAY HYDROGRAPH. ALL VALUES IN THESE TABLES CAME FROM EXHIBITS 21.1, 21-2, AND 21-3 OF THE SOIL CONSERVATION SERVICE NATIONAL ENGINEERING HANDBOOK, SECTION 4, HYDROLOGY.

DIVISION OF WATER RESURECES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIROMENTAL PROTECTION
ENGINEERING MEMORADUM NO.2 (4-30-71), REVISED (6-1-79)

30 MINUTE RAINFALL (INCHES)

	FREQUENCY (YEARS)						
COUNTY	1	2	5	10	25	50	100
ADAIR	1.0	1.2	1.4	1.7	1.9	2.1	2.4
ALLEN	1.0	1.2	1.5	1.7	1.9	2.1	2.4
ANDERSON	0.9	1.1	1.4	1.6	1.9	2.0	2.3
BALLARD	1.1	1.3	1.6	1.8	2.0	2.2	2.5
BARREN	1.0	1.2	1.5	1.7	1.9	2.1	2.4
BATH	0.9	1.1	1.4	1.6	1.8	2.0	2.2
BELL	1.0	1.1	1.5	1.7	1.9	2.1	2.4
BOONE	0.9	1.1	1.4	1.6	1.8	2.0	2.2
BOURBON	0.9	1.1	1.4	1.6	1.8	2.0	2.2
BOYD	0.9	1.1	1.4	1.6	1.8	2.0	2.2
BOYLE	0.9	1.1	1.4	1.6	1.9	2.1	2.3
BRACKEN	0.9	1.1	1.4	1.6	1.8	2.0	2.2
BREATHITT	0.9	1.1	1.4	1.6	1.9	2.1	2.3
BRECKENRIDGE	1.0	1.2	1.4	1.7	1.9	2.1	2.3
BULLITT	1.0	1.1	1.4	1.6	1.9	2.1	2.3
BUTLER	1.0	1.2	1.5	1.7	1.9	2.1	2.4
CALDWELL	1.1	1.2	1.5	1.8	2.0	2.2	2.4
CALLOWAY	1.1	1.2	1.6	1.8	2.0	2.2	2.5
CAMPBELL	0.9	1.1	1.4	1.6	1.8	2.0	2.2
CARLISLE	1.1	1.3	1.6	1.8	2.0	2.3	2.5
CARROLL	0.9	1.1	1.4	1.6	1.8	2.0	2.2
CARTER	0.9	1.1	1.4	1.6	1.8	2.0	2.2
CASEY	1.0	1.1	1.4	1.7	1.9	2.1	2.3
CHRISTIAN	1.0	1.2	1.5	1.7	2.0	2.2	2.4
CLARK	0.9	1.1	1.4	1.6	1.8	2.1	2.3
CLAY	0.9	1.1	1.4	1.7	1.9	2.1	2.3
CLINTON	1.0	1.2	1.5	1.7	1.9	2.1	2.4
CRITTENDEN	1.1	1.2	1.5	1.8	2.0	2.2	2.4
CUMBERLAND	1.0	1.2	1.5	1.7	1.9	2.1	2.4
DAVIESS	1.0	1.2	1.5	1.7	1.9	2.1	2.3
EDMONSON	1.0	1.2	1.5	1.7	1.9	2.1	2.3
ELLIOTT	0.9	1.1	1.4	1.6	1.8	2.1	2.2
ESTILL	0.9	1.1	1.4	1.6	1.9	2.1	2.3
FAYETTE	0.9	1.1	1.4	1.6	1.8	2.1	2.3
FLEMING	0.9	1.1	1.4	1.6	1.8	2.0	2.2
FLOYD	0.9	1.1	1.4	1.6	1.9	2.1	2.3
FRANKLIN	0.9	1.1	1.4	1.6	1.8	2.0	2.3
FULTON	1.1	1.3	1.6	1.8	2.0	2.3	2.5
GALLATIN	0.9	1.1	1.4	1.6	1.9	2.1	2.2
GARRARD	0.9	1.1	1.4	1.6	1.9	2.1	2.3

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESLURCES AND ENVIONMENTAL PROTECTION
ENGINEERING MEMORADUM NO.2 (4-30-71), REVISED (6-1-79)

30 MINUTE RAINFALL (INCHES)

	FREQUENCY (YEARS)						
COUNTY	1	2	5	10	25	50	100
GRANT	0.9	1.1	1.4	1.6	1.8	2.0	2.2
GRAVES	1.1	1.3	1.6	1.8	2.0	2.2	2.5
GRAYSON	1.0	1.2	1.4	1.7	1.9	2.1	2.3
GREEN	1.0	1.1	1.4	1.7	1.9	2.1	2.3
GREENUP	0.9	1.1	1.4	1.6	1.8	2.0	2.2
HANCOCK	1.0	1.2	1.4	1.7	1.9	2.1	2.3
HARDIN	1.0	1.2	1.4	1.6	1.9	2.1	2.3
HARLIN	1.0	1.1	1.5	1.7	1.9	2.1	2.3
HARRISON	0.9	1.1	1.4	1.6	1.8	2.0	2.2
HART	1.0	1.2	1.4	1.7	1.9	2.1	2.3
HENDERSON	1.0	1.2	1.5	1.7	1.9	2.1	2.3
HENRY	0.9	1.1	1.4	1.6	1.8	2.0	2.2
HICKMAN	1.1	1.3	1.6	1.8	2.0	2.3	2.5
HOPKINS	1.0	1.2	1.5	1.7	1.9	2.1	2.4
JACKSON	0.9	1.1	1.4	1.6	1.9	2.1	2.3
JEFFERSON	1.0	1.1	1.4	1.6	1.9	2.0	2.3
JESSAMINE	0.9	1.1	1.4	1.6	1.9	2.1	2.3
JOHNSON	0.9	1.1	1.4	1.6	1.9	2.1	2.3
KENTON	0.9	1.1	1.4	1.6	1.8	2.0	2.2
KNOTT	0.9	1.1	1.4	1.6	1.9	2.1	2.3
KNOX	1.0	1.1	1.5	1.7	1.9	2.1	2.3
LARUE	1.0	1.1	1.4	1.7	1.9	2.1	2.3
LAURAL	1.0	1.1	1.4	1.7	1.9	2.1	2.3
LAWRENCE	0.9	1.1	1.4	1.6	1.8	2.1	2.2
LEE	0.9	1.1	1.4	1.6	1.9	2.1	2.3
LESLIE	0.9	1.1	1.4	1.7	1.9	2.1	2.3
LETCHER	0.9	1.1	1.4	1.7	1.9	2.1	2.3
LEWIS	0.9	1.1	1.4	1.6	1.8	2.0	2.2
LINCOLN	0.9	1.1	1.4	1.6	1.9	2.1	2.3
LIVINGSTON	1.1	1.2	1.5	1.8	2.0	2.2	2.4
LOGAN	1.0	1.2	1.5	1.7	1.9	2.1	2.4
LYON	1.0	1.2	1.5	1.8	2.0	2.2	2.4
MCCRACKEN	1.0	1.3	1.6	1.8	2.0	2.2	2.5
MCCREARY	1.0	1.2	1.5	1.7	1.9	2.1	2.4
MCLEAN	1.0	1.2	1.5	1.7	1.9	2.1	2.4
MADISON	0.9	1.1	1.4	1.6	1.9	2.1	2.3
MAGOFFIN	0.9	1.1	1.4	1.6	1.9	2.1	2.3
MARION	1.0	1.1	1.4	1.6	1.9	2.1	2.3
MARSHALL	1.0	1.2	1.6	1.8	2.0	2.2	2.5
MARTIN	0.9	1.1	1.4	1.6	1.9	2.1	2.3

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)

30 MINUTE RAINFALL (INCHES)

	FREQUENCY (YEARS)						
COUNT	1	2	5	10	25	50	100
MASON	0.9	1.1	1.4	1.6	1.8	2.0	2.2
MEADE	1.0	1.2	1.4	1.6	1.9	2.1	2.3
MENIFEE	0.9	1.1	1.4	1.6	1.9	2.1	2.3
MERCER	0.9	1.1	1.4	1.6	1.9	2.1	2.3
METCALFE	1.0	1.2	1.5	1.7	1.9	2.1	2.4
MONROE	1.0	1.2	1.5	1.7	1.9	2.1	2.4
MONTGOMERY	0.9	1.1	1.4	1.6	1.8	2.1	2.3
MORGAN	0.9	1.1	1.4	1.6	1.8	2.1	2.3
MUHLENBERG	1.0	1.2	1.5	1.7	1.9	2.1	2.4
NELSON	1.0	1.1	1.4	1.6	1.9	2.1	2.3
NICHOLAS	0.9	1.1	1.4	1.6	1.8	2.0	2.2
OHIO	1.0	1.2	1.5	1.7	1.9	2.1	2.3
OLDHAM	0.9	1.1	1.4	1.6	1.8	2.0	2.2
OWEN	0.9	1.1	1.4	1.6	1.8	2.0	2.2
OWSLEY	0.9	1.1	1.4	1.6	1.9	2.1	2.3
PENDLETON	0.9	1.1	1.4	1.6	1.8	2.0	2.2
PERRY	0.9	1.1	1.4	1.7	1.9	2.1	2.3
PIKE	0.9	1.1	1.4	1.6	1.9	2.1	2.3
POWELL	0.9	1.1	1.4	1.6	1.9	2.1	2.3
PULASKI	1.0	1.1	1.4	1.7	1.9	2.1	2.3
ROBERTSON	0.9	1.1	1.4	1.6	1.8	2.0	2.2
ROCKCASTLE	0.9	1.1	1.4	1.6	1.9	2.1	2.3
ROWAN	0.9	1.1	1.4	1.6	1.8	2.0	2.2
RUSSELL	1.0	1.1	1.4	1.7	1.9	2.1	2.3
SCOTT	0.9	1.1	1.4	1.6	1.8	2.0	2.2
SHELBY	0.9	1.1	1.4	1.6	1.8	2.0	2.3
SIMPSON	1.0	1.2	1.5	1.7	1.9	2.1	2.4
SPENCER	0.9	1.1	1.4	1.6	1.9	2.0	2.3
TAYLOR	1.0	1.1	1.4	1.7	1.9	2.1	2.3
TODD	1.0	1.2	1.5	1.7	1.9	2.1	2.4
TRIGG	1.1	1.2	1.5	1.8	2.0	2.2	2.4
TRIMBLE	0.9	1.1	1.4	1.6	1.8	2.0	2.2
UNION	1.0	1.2	1.5	1.7	2.0	2.2	2.4
WARREN	1.0	1.2	1.5	1.7	1.9	2.1	2.4
WASHINGTON	1.0	1.1	1.4	1.6	1.9	2.1	2.3
WAYNE	1.0	1.2	1.5	1.7	1.9	2.1	2.4
WEBSTER	1.0	1.2	1.5	1.7	1.9	2.1	2.4
WHITLEY	1.0	1.2	1.5	1.7	1.9	2.1	2.4
WOLFE	0.9	1.1	1.4	1.6	1.9	2.1	2.3
WOODFORD	0.9	1.1	1.4	1.6	1.9	2.0	2.3

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)

1 HOUR RAINFALL (INCHES)

	FREQUENCY	(YEARS)					
COUNTY	1	2	5	10	25	50	100
ADAIR	1.2	1.4	1.8	2.1	2.4	2.7	2.9
ALLEN	1.2	1.5	1.8	2.1	2.4	2.7	2.9
ANDERSON	1.2	1.4	1.7	2.0	2.3	2.6	2.8
BALLARD	1.3	1.6	2.0	2.3	2.6	2.9	3.1
BARREN	1.2	1.4	1.8	2.1	2.4	2.7	2.9
BATH	1.1	1.3	1.7	2.0	2.3	2.6	2.8
BELL	1.2	1.4	1.8	2.2	2.4	2.7	3.0
BOONE	1.1	1.4	1.7	2.0	2.3	2.5	2.8
BOURBON	1.1	1.3	1.7	2.0	2.3	2.6	2.8
BOYD	1.1	1.3	1.7	2.0	2.3	2.6	2.9
BOYLE	1.2	1.4	1.8	2.1	2.4	2.6	2.9
BRACKEN	1.1	1.3	1.7	2.0	2.2	2.5	2.8
BREATHITT	1.1	1.3	1.8	2.1	2.4	2.6	2.9
BRECKINRIDGE	1.2	1.4	1.8	2.1	2.4	2.6	2.9
BULLITT	1.2	1.4	1.8	2.1	2.3	2.6	2.8
BUTLER	1.2	1.5	1.8	2.1	2.4	2.7	2.9
CALDWELL	1.3	1.5	1.9	2.2	2.5	2.8	3.0
CALLOWAY	1.3	1.6	2.0	2.2	2.6	2.8	3.1
CAMPBELL	1.1	1.3	1.7	2.0	2.3	2.5	2.8
CARLISLE	1.3	1.6	2.0	2.3	2.6	2.9	3.2
CARROLL	1.1	1.4	1.7	2.0	2.3	2.5	2.8
CARTER	1.1	1.3	1.7	2.0	2.3	2.6	2.8
CASEY	1.2	1.4	1.8	2.1	2.4	2.6	2.9
CHRISTIAN	1.3	1.5	1.9	2.2	2.5	2.8	3.0
CLARK	1.1	1.4	1.7	2.0	2.3	2.6	2.8
CLAY	1.2	1.4	1.8	2.1	2.4	2.7	2.9
CLINTON	1.2	1.4	1.8	2.1	2.4	2.7	2.9
CRITTENDEN	1.3	1.5	1.9	2.2	2.5	2.8	3.0
CUMBERLAND	1.2	1.4	1.8	2.1	2.4	2.7	2.9
DAVIESS	1.2	1.5	1.9	2.1	2.4	2.7	3.0
EDMONSON	1.2	1.5	1.8	2.1	2.4	2.7	2.9
ELLIOTT	1.1	1.3	1.7	2.0	2.3	2.6	2.9
ESTILL	1.1	1.4	1.7	2.1	2.3	2.6	2.9
FAYETTE	1.1	1.4	1.7	2.0	2.3	2.6	2.8
FLEMING	1.1	1.3	1.7	2.0	2.3	2.5	2.8
FLOYD	1.1	1.4	1.8	2.1	2.4	2.7	2.9
FRANKLIN	1.1	1.4	1.7	2.0	2.3	2.6	2.8
FULTON	1.3	1.6	2.0	2.3	2.7	2.9	3.2
GALLATIN	1.1	1.4	1.7	2.0	2.3	2.5	2.8
GARRARD	1.1	1.4	1.8	2.1	2.3	2.6	2.9

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)

1 HOUR RAINFALL (INCHES)

	FREQUENCY (YEARS)						
COUNTY	1	2	5	10	25	50	100
GRANT	1.1	1.4	1.7	2.0	2.3	2.5	2.8
GRAVES	1.3	1.6	2.0	2.2	2.6	2.8	3.1
GRAYSON	1.2	1.4	1.8	2.1	2.4	2.7	2.9
GREEN	1.2	1.4	1.8	2.1	2.4	2.7	2.9
GREENUP	1.1	1.3	1.7	2.0	2.3	2.6	2.8
HANCOCK	1.2	1.5	1.8	2.1	2.4	2.7	2.9
HARDIN	1.2	1.4	1.8	2.1	2.4	2.6	2.9
HARLAN	1.2	1.4	1.8	2.1	2.4	2.7	3.0
HARRISON	1.1	1.3	1.7	2.0	2.3	2.5	2.8
HART	1.2	1.4	1.8	2.1	2.4	2.7	2.9
HENDERSON	1.3	1.5	1.9	2.1	2.4	2.7	3.0
HENRY	1.2	1.4	1.7	2.0	2.3	2.6	2.8
HICKMAN	1.3	1.6	2.0	2.3	2.6	2.9	3.2
HOPKINS	1.3	1.5	1.9	2.2	2.5	2.7	3.0
JACKSON	1.2	1.4	1.8	2.1	2.4	2.6	2.9
JEFFERSON	1.2	1.4	1.8	2.0	2.3	2.6	2.8
JESSAMINE	1.1	1.4	1.7	2.1	2.3	2.6	2.8
JOHNSON	1.1	1.3	1.7	2.1	2.3	2.6	2.9
KENTON	1.1	1.4	1.7	2.0	2.3	2.5	2.8
KNOTT	1.1	1.4	1.8	2.1	2.4	2.7	2.9
KNOX	1.2	1.4	1.8	2.1	2.4	2.7	2.9
LARUE	1.2	1.4	1.8	2.1	2.4	2.6	2.9
LAUREL	1.2	1.4	1.8	2.1	2.4	2.7	2.9
LAWRENCE	1.1	1.3	1.7	2.0	2.3	2.6	2.9
LEE	1.1	1.4	1.8	2.1	2.3	2.6	2.9
LESLIE	1.2	1.4	1.8	2.1	2.4	2.7	2.9
LETCHER	1.2	1.4	1.8	2.1	2.4	2.7	3.0
LEWIS	1.1	1.3	1.7	2.0	2.3	2.5	2.8
LINCOLN	1.2	1.4	1.8	2.1	2.4	2.6	2.9
LIVINGSTON	1.3	1.5	2.0	2.3	2.5	2.8	3.1
LOGAN	1.2	1.5	1.9	2.2	2.4	2.7	3.0
LYON	1.3	1.5	2.0	2.2	2.5	2.8	3.0
MCCRACKEN	1.3	1.6	2.0	2.2	2.6	2.8	3.1
MCCREARY	1.2	1.4	1.8	2.2	2.4	2.7	2.9
MCLEAN	1.2	1.5	1.9	2.1	2.4	2.7	3.0
MADISON	1.1	1.4	1.8	2.1	2.3	2.6	2.9
MAGOFFIN	1.1	1.3	1.8	2.1	2.3	2.6	2.9
MARION	1.2	1.4	1.8	2.1	2.3	2.6	2.9
MARSHALL	1.3	1.6	2.0	2.2	2.6	2.8	3.1
MARTIN	1.1	1.3	1.7	2.1	2.3	2.6	2.9

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO. 2 (4-30-71), REVISED (6-1-79)

1 HOUR RAINFALL (INCHES)

	FREQUENCY (YEARS)						
COUNTY	1	2	5	10	25	50	100
MASON	1.1	1.3	1.7	2.0	2.3	2.5	2.8
MEADE	1.2	1.4	1.8	2.1	2.4	2.6	2.9
MENIFEE	1.1	1.3	1.7	2.0	2.3	2.6	2.9
MERCER	1.2	1.4	1.8	2.1	2.3	2.6	2.8
METCALFE	1.2	1.4	1.8	2.1	2.4	2.7	2.9
MONROE	1.2	1.4	1.8	2.1	2.4	2.7	2.9
MONTGOMERY	1.1	1.3	1.7	2.0	2.3	2.6	2.8
MORGAN	1.1	1.3	1.7	2.1	2.3	2.6	2.9
MUHLENBERG	1.2	1.5	1.9	2.1	2.5	2.7	3.0
NELSON	1.2	1.4	1.8	2.1	2.3	2.6	2.9
NICHOLAS	1.1	1.3	1.7	2.0	2.3	2.6	2.8
OHIO	1.2	1.5	1.8	2.1	2.4	2.7	2.9
OLDHAM	1.2	1.4	1.8	2.0	2.3	2.6	2.8
OWEN	1.1	1.4	1.7	2.0	2.3	2.6	2.8
OWSLEY	1.1	1.4	1.8	2.1	2.4	2.6	2.9
PENDLETON	1.1	1.3	1.7	2.0	2.3	2.5	2.8
PERRY	1.2	1.4	1.8	2.1	2.4	2.7	3.0
PIKE	1.1	1.4	1.8	2.1	2.4	2.7	3.0
POWELL	1.1	1.3	1.7	2.1	2.3	2.6	2.9
PULASKI	1.2	1.4	1.8	2.1	2.4	2.7	2.9
ROBERTSON	1.1	1.3	1.7	2.0	2.3	2.5	2.8
ROCKCASTLE	1.2	1.4	1.8	2.1	2.4	2.6	2.9
ROWAN	1.1	1.3	1.7	2.0	2.3	2.6	2.8
RUSSELL	1.2	1.4	1.8	2.1	2.4	2.7	2.9
SCOTT	1.1	1.4	1.7	2.0	2.3	2.6	2.8
SHELBY	1.2	1.4	1.8	2.0	2.3	2.6	2.8
SIMPSON	1.2	1.5	1.9	2.2	2.4	2.7	2.9
SPENCER	1.2	1.4	1.8	2.1	2.3	2.6	2.8
TAYLOR	1.2	1.4	1.8	2.1	2.4	2.7	2.9
TODD	1.3	1.5	1.9	2.2	2.5	2.7	3.0
TRIGG	1.3	1.5	2.0	2.2	2.5	2.8	3.0
TRIMBLE	1.2	1.4	1.8	2.0	2.3	2.6	2.8
UNION	1.3	1.5	1.9	2.2	2.5	2.8	3.0
WARREN	1.2	1.5	1.8	2.1	2.4	2.7	2.9
WASHINGTON	1.2	1.4	1.8	2.1	2.3	2.6	2.8
WAYNE	1.2	1.4	1.8	2.1	2.4	2.7	2.9
WEBSTER	1.3	1.5	1.9	2.2	2.4	2.8	3.0
WHITLEY	1.2	1.4	1.8	2.2	2.4	2.7	2.9
WOLFE	1.1	1.3	1.7	2.1	2.3	2.6	2.9
WOODFORD	1.1	1.4	1.7	2.0	2.3	2.6	2.8

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2 HOURS RAINFALL (INCHES)

	FREQUENCY (YEARS)						
COUNTY	1	2	5	10	25	50	100
ADAIR	1.5	1.8	2.3	2.5	2.9	3.3	3.6
ALLEN	1.5	1.8	2.3	2.6	3.0	3.3	3.7
ANDERSON	1.5	1.7	2.2	2.5	2.8	3.2	3.4
BALLARD	1.7	1.9	2.4	2.8	3.2	3.5	3.9
BARREN	1.5	1.8	2.3	2.6	2.9	3.3	3.7
BATH	1.4	1.8	2.1	2.4	2.8	3.1	3.4
BELL	1.5	1.7	2.3	2.5	2.9	3.3	3.6
BOONE	1.4	1.7	2.1	2.4	2.7	3.1	3.3
BOURBON	1.4	1.7	2.1	2.4	2.8	3.1	3.4
BOYD	1.4	1.6	2.1	2.4	2.8	3.1	3.4
BOYLE	1.5	1.7	2.2	2.5	2.8	3.2	3.5
BRACKEN	1.4	1.6	2.1	2.4	2.7	3.1	3.3
BREATHITT	1.4	1.7	2.2	2.4	2.8	3.2	3.5
BRECKINRIDGE	1.5	1.8	2.2	2.5	2.9	3.2	3.6
BULLITT	1.5	1.8	2.2	2.5	2.8	3.2	3.5
BUTLER	1.6	1.8	2.3	2.6	2.9	3.3	3.7
CALDWELL	1.6	1.9	2.3	2.7	3.0	3.4	3.8
CALLOWAY	1.6	1.9	2.4	2.8	3.1	3.5	3.9
CAMPBELL	1.4	1.6	2.1	2.4	2.7	3.1	3.3
CARLISLE	1.7	1.9	2.4	2.8	3.2	3.5	3.9
CARROLL	1.5	1.7	2.1	2.4	2.8	3.1	3.4
CARTER	1.4	1.6	2.1	2.4	2.7	3.1	3.4
CASEY	1.5	1.7	2.2	2.5	2.9	3.2	3.5
CHRISTIAN	1.6	1.9	2.3	2.7	3.0	3.4	3.8
CLARK	1.4	1.7	2.2	2.4	2.8	3.1	3.4
CLAY	1.5	1.7	2.2	2.5	2.9	3.2	3.5
CLINTON	1.5	1.8	2.3	2.6	2.9	3.3	3.6
CRITTENDEN	1.6	1.9	2.3	2.7	3.0	3.4	3.8
CUMBERLAND	1.5	1.8	2.3	2.6	2.9	3.3	3.6
DAVIESS	1.6	1.8	2.3	2.6	2.9	3.3	3.6
EDMONSON	1.5	1.8	2.3	2.6	2.9	3.3	3.6
ELLIOTT	1.4	1.6	2.1	2.4	2.8	3.1	3.4
ESTILL	1.4	1.7	2.2	2.4	2.8	3.2	3.4
FAYETTE	1.4	1.7	2.1	2.4	2.8	3.1	3.4
FLEMING	1.4	1.6	2.1	2.4	2.7	3.1	3.4
FLOYD	1.4	1.6	2.2	2.4	2.8	3.2	3.4
FRANKLIN	1.5	1.7	2.1	2.4	2.8	3.1	3.4
FULTON	1.7	1.9	2.4	2.8	3.2	3.5	3.9
GALLATIN	1.5	1.7	2.1	2.4	2.7	3.1	3.3
GARRARD	1.5	1.7	2.2	2.5	2.8	3.2	3.5

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2 HOUR RAINFALL (INCHES)

	FREQUENCY (YEARS)						
COUNTY	1	2	5	10	25	50	100
GRANT	1.4	1.7	2.1	2.4	2.7	3.1	3.3
GRAVES	1.7	1.9	2.4	2.8	3.1	3.5	3.9
GRAYSON	1.5	1.8	2.3	2.6	2.9	3.3	3.6
GREEN	1.5	1.8	2.2	2.5	2.9	3.3	3.6
GREENUP	1.4	1.6	2.0	2.3	2.7	3.0	3.3
HANCOCK	1.6	1.8	2.3	2.6	2.9	3.2	3.6
HARDIN	1.5	1.8	2.2	2.5	2.9	3.2	3.5
HARLAN	1.5	1.7	2.3	2.5	2.9	3.3	3.6
HARRISON	1.4	1.7	2.1	2.4	2.7	3.1	3.4
HART	1.5	1.8	2.3	2.5	2.9	3.3	3.6
HENDERSON	1.6	1.8	2.3	2.6	3.0	3.3	3.7
HENRY	1.5	1.7	2.1	2.4	2.8	3.1	3.4
HICKMAN	1.7	1.9	2.4	2.8	3.2	3.5	3.9
HOPKINS	1.6	1.9	2.3	2.7	3.0	3.3	3.7
JACKSON	1.4	1.7	2.2	2.5	2.9	3.2	3.5
JEFFERSON	1.5	1.7	2.2	2.5	2.8	3.2	3.5
JESSAMINE	1.5	1.7	2.2	2.4	2.8	3.2	3.4
JOHNSON	1.4	1.6	2.1	2.4	2.8	3.1	3.4
KENTON	1.4	1.6	2.1	2.4	2.7	3.0	3.3
KNOTT	1.4	1.7	2.2	2.4	2.9	3.2	3.5
KNOX	1.5	1.7	2.3	2.5	2.9	3.3	3.5
LARUE	1.5	1.8	2.2	2.5	2.9	3.2	3.6
LAUREL	1.5	1.7	2.2	2.5	2.9	3.2	3.5
LAWRENCE	1.4	1.6	2.1	2.4	2.8	3.1	3.4
LEE	1.4	1.7	2.2	2.4	2.8	3.2	3.4
LESLIE	1.5	1.7	2.3	2.5	2.9	3.2	3.5
LETCHER	1.4	1.7	2.3	2.5	2.9	3.2	3.5
LEWIS	1.4	1.6	2.1	2.4	2.7	3.0	3.3
LINCOLN	1.5	1.7	2.2	2.5	2.9	3.2	3.5
LIVINSTON	1.6	1.9	2.4	2.7	3.1	3.4	3.8
LOGAN	1.6	1.8	2.3	2.7	3.0	3.3	3.7
LYON	1.6	1.9	2.4	2.7	3.1	3.4	3.8
MCCRACKEN	1.7	1.9	2.4	2.8	3.1	3.4	3.8
MCCREARY	1.5	1.8	2.3	2.6	2.9	3.3	3.6
MCLEAN	1.6	1.8	2.3	2.6	3.0	3.3	3.7
MADISON	1.5	1.7	2.2	2.4	2.8	3.2	3.4
MAGOFFIN	1.4	1.7	2.2	2.4	2.8	3.1	3.4
MARION	1.5	1.7	2.2	2.5	2.9	3.2	3.5
MARSHALL	1.6	1.9	2.4	2.8	3.1	3.4	3.8
MARTIN	1.4	1.6	2.2	2.4	2.8	3.1	3.4

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2 HOUR RAINFALL (INCHES)

	FREQUENCY (YEARS)						
COUNTY	1	2	5	10	25	50	100
MASON	1.4	1.6	2.1	2.4	2.7	3.0	3.3
MEADE	1.5	1.8	2.2	2.5	2.9	3.2	3.5
MENIFEE	1.4	1.7	2.1	2.4	2.8	3.1	3.4
MERCER	1.5	1.7	2.2	2.5	2.8	3.2	3.5
METCALFE	1.5	1.8	2.3	2.6	2.9	3.3	3.6
MONROE	1.5	1.8	2.3	2.6	2.9	3.3	3.7
MONTGOMERY	1.4	1.7	2.1	2.4	2.8	3.1	3.4
MORGAN	1.4	1.6	2.1	2.4	2.8	3.1	3.4
MUHLENBERG	1.6	1.9	2.3	2.7	3.0	3.3	3.7
NELSON	1.5	1.8	2.2	2.5	2.8	3.2	3.5
NICHOLAS	1.4	1.6	2.1	2.4	2.7	3.1	3.4
OHIO	1.6	1.8	2.3	2.4	2.9	3.3	3.7
OLDHAM	1.5	1.7	2.1	2.4	2.8	3.1	3.4
OWEN	1.5	1.7	2.1	2.4	2.8	3.1	3.4
OWSLEY	1.4	1.7	2.2	2.4	2.9	3.2	3.5
PENDLETON	1.4	1.7	2.1	2.4	2.7	3.1	3.3
PERRY	1.4	1.7	2.2	2.5	2.9	3.2	3.5
PIKE	1.4	1.7	2.2	2.4	2.9	3.2	3.5
POWELL	1.4	1.7	2.2	2.4	2.8	3.1	3.4
PULASKI	1.5	1.7	2.2	2.5	2.9	3.3	3.5
ROBERTSON	1.4	1.6	2.1	2.4	2.7	3.1	3.3
ROCKCASTLE	1.5	1.7	2.2	2.5	2.9	3.2	3.5
ROWAN	1.4	1.6	2.1	2.4	2.8	3.1	3.4
RUSSELL	1.5	1.7	2.3	2.5	2.9	3.3	3.6
SCOTT	1.4	1.7	2.1	2.4	2.7	3.1	3.3
SHELBY	1.5	1.7	2.2	2.4	2.8	3.2	3.4
SIMPSON	1.6	1.8	2.3	2.7	3.0	3.3	3.7
SPENCER	1.5	1.7	2.2	2.5	2.8	3.2	3.5
TAYLOR	1.5	1.8	2.2	2.5	2.9	3.2	3.5
TODD	1.6	1.8	2.3	2.9	3.0	3.3	3.8
TRIGG	1.6	1.9	2.4	2.7	3.1	3.4	3.8
TRIMBLE	1.5	1.7	2.1	2.4	2.8	3.1	3.4
UNION	1.6	1.9	2.3	2.7	3.0	3.3	3.7
WARREN	1.5	1.8	2.3	2.6	2.9	3.3	3.7
WASHINGTON	1.5	1.7	2.2	2.5	2.8	3.2	3.5
WAYNE	1.5	1.8	2.3	2.6	2.9	3.3	3.6
WEBSTER	1.6	1.9	2.3	2.7	3.0	3.3	3.7
WHITLEY	1.5	1.8	2.3	2.6	2.9	3.3	3.6
WOLFE	1.4	1.7	2.2	2.4	2.8	3.2	3.4
WOODFORD	1.5	1.7	2.2	2.4	2.8	3.2	3.4

DIVISION OF WATER RESOURCES
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3 HOUR RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	1	2	5	10	25	50	100
ADAIR	1.6	2.0	2.4	2.8	3.3	3.5	3.9
ALLEN	1.7	2.0	2.5	2.8	3.3	3.6	4.0
ANDERSON	1.6	1.9	2.3	2.7	3.2	3.4	3.7
BALLARD	1.9	2.2	2.7	3.0	3.5	3.9	4.3
BARREN	1.7	2.0	2.5	2.8	3.3	3.6	3.0
BATH	1.5	1.8	2.3	2.6	3.1	3.3	3.6
BELL	1.6	1.9	2.4	2.8	3.3	3.5	3.9
BOONE	1.5	1.8	2.2	2.6	3.0	3.3	3.6
BOURBON	1.5	1.8	2.3	2.6	3.1	3.3	3.6
BOYD	1.5	1.8	2.2	2.6	2.9	3.2	3.6
BOYLE	1.6	1.9	2.4	2.7	3.2	3.4	3.8
BRACKEN	1.5	1.8	2.2	2.6	3.0	3.3	3.6
BREATHITT	1.5	1.9	2.3	2.7	3.1	3.4	3.7
BRECKINRIDGE	1.7	2.0	2.5	2.8	3.3	3.5	3.9
BULLITT	1.6	1.9	2.4	2.7	3.2	3.5	3.8
BUTLER	1.7	2.0	2.5	2.8	3.3	3.6	4.0
CALDWELL	1.8	2.1	2.6	2.9	3.4	3.7	4.2
CALLOWAY	1.8	2.1	2.7	3.0	3.4	3.8	4.2
CAMPBELL	1.5	1.8	2.2	2.6	3.0	3.3	3.6
CARLISLE	1.9	2.2	2.7	3.1	3.5	3.9	4.3
CARROLL	1.5	1.9	2.3	2.6	3.1	3.4	3.7
CARTER	1.5	1.8	2.2	2.6	3.0	3.3	3.6
CASEY	1.6	1.9	2.4	2.7	3.2	3.5	3.8
CHRISTIAN	1.8	2.1	2.6	2.9	3.4	3.7	4.1
CLARK	1.5	1.9	2.3	2.6	3.1	3.4	3.7
CLAY	1.6	1.9	2.4	2.8	3.2	3.4	3.8
CLINTON	1.7	2.0	2.5	2.8	3.3	3.6	3.9
CRITTENDEN	1.8	2.1	2.6	2.9	3.4	3.7	4.2
CUMBERLAND	1.7	2.0	2.5	2.8	3.3	3.6	3.9
DAVIESS	1.7	2.0	2.5	2.8	3.3	3.6	4.0
EDMONSON	1.7	2.0	2.5	2.8	3.3	3.6	4.0
ELLIOTT	1.5	1.8	2.2	2.6	3.0	3.3	3.6
ESTILL	1.6	1.9	2.3	2.7	3.2	3.4	3.7
FAYETTE	1.6	1.9	2.3	2.6	3.1	3.4	3.7
FLEMING	1.5	1.8	2.2	2.6	3.0	3.3	3.6
FLOYD	1.5	1.9	2.3	2.7	3.1	3.4	3.7
FRANKLIN	1.6	1.9	2.3	2.6	3.1	3.4	3.7
FULTON	1.9	2.2	2.7	3.1	3.5	3.9	4.4
GALLATIN	1.5	1.8	2.3	2.6	3.1	3.3	3.6
GARRARD	1.6	1.9	2.3	2.7	3.2	3.4	3.7

3 HOUR RAINFALL (INCHES)

	FREQUENCY (YEARS)						
COUNTY	1	2	5	10	25	50	100
GRANT	1.5	1.8	2.3	2.6	3.1	3.3	3.6
GRAVES	1.9	2.2	2.7	3.0	3.5	3.9	4.3
GRAYSON	1.7	2.0	2.5	2.8	3.3	3.6	3.9
GREEN	1.7	2.0	2.4	2.8	3.3	3.5	3.9
GREENUP	1.5	1.8	2.2	2.5	2.9	3.2	3.5
HANCOCK	1.7	2.0	2.5	2.8	3.3	3.5	4.0
HARDIN	1.7	2.0	2.4	2.8	3.2	3.5	3.9
HARLAN	1.6	1.9	2.4	2.8	3.3	3.5	3.9
HARRISON	1.5	1.8	2.3	2.6	3.1	3.3	3.6
HART	1.7	2.0	2.5	2.8	3.3	3.5	3.9
HENDERSON	1.8	2.0	2.5	2.9	3.3	3.6	4.0
HENRY	1.6	1.9	2.3	2.7	3.1	3.4	3.7
HICKMAN	1.9	2.2	2.7	3.1	3.5	3.9	4.3
HOPKINS	1.8	2.1	2.6	2.9	3.4	3.7	4.1
JACKSON	1.6	1.9	2.3	2.7	3.2	3.4	3.7
JEFFERSON	1.6	1.9	2.4	2.7	3.2	3.4	3.8
JESSAMINE	1.6	1.9	2.3	2.7	3.2	3.4	3.7
JOHNSON	1.5	1.8	2.3	2.7	3.0	3.3	3.6
KENTON	1.5	1.8	2.2	2.6	3.0	3.3	3.6
KNOTT	1.5	1.9	2.3	2.8	3.2	3.4	3.8
KNOX	1.6	1.9	2.4	2.8	3.3	3.5	3.8
LARUE	1.6	2.0	2.4	2.7	3.2	3.5	3.9
LAUREL	1.6	1.9	2.4	2.8	3.2	3.5	3.8
LAWRENCE	1.5	1.8	2.2	2.6	3.0	3.3	3.6
LEE	1.5	1.9	2.3	2.7	3.2	3.4	3.7
LESLIE	1.6	1.9	2.4	2.8	3.2	3.4	3.8
LETCHER	1.5	1.9	2.3	2.8	3.2	3.4	3.8
LEWIS	1.5	1.8	2.2	2.6	3.0	3.3	3.6
LINCOLN	1.6	1.9	2.4	2.7	3.2	3.4	3.8
LIVINGTON	1.8	2.1	2.6	3.0	3.4	3.8	4.2
LOGAN	1.7	2.0	2.5	2.9	3.4	3.7	4.0
LYON	1.8	2.1	2.6	3.0	3.4	3.8	4.2
MCCRACKEN	1.9	2.1	2.7	3.0	3.4	3.8	4.3
MCCREARY	1.6	2.0	2.4	2.8	3.3	3.5	3.9
MCLEAN	1.7	2.0	2.5	2.9	3.3	3.6	4.0
MADISON	1.6	1.9	2.3	2.7	3.2	3.4	3.7
MAGOFFIN	1.5	1.8	2.3	2.7	3.1	3.3	3.7
MARION	1.6	1.9	2.4	2.7	3.2	3.5	3.8
MARSHALL	1.8	2.1	2.6	3.0	3.4	3.8	4.2
MARTIN	1.5	1.8	2.3	2.7	3.0	3.3	3.7

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79

3 HOUR RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	1	2	5	10	25	50	100
MASON	1.5	1.8	2.2	2.6	3.0	3.3	3.6
MEADE	1.7	2.0	2.4	2.8	3.2	3.5	3.9
MENIFEE	1.5	1.8	2.3	2.6	3.1	3.3	3.6
MERCER	1.6	1.9	2.4	2.7	3.2	3.4	3.7
METCALFE	1.7	2.0	2.5	2.8	3.3	3.6	3.9
MONROE	1.7	2.0	2.5	2.8	3.3	3.6	4.0
MONTGOMERY	1.5	1.8	2.3	2.6	3.1	3.3	3.6
MORGAN	1.5	1.8	2.3	2.6	3.1	3.3	3.6
MUHLENBERG	1.7	2.0	2.5	2.9	3.3	3.7	4.0
NELSON	1.6	1.9	2.4	2.7	3.2	3.5	3.8
NICHOLAS	1.5	1.8	2.3	2.6	3.1	3.3	3.6
OHIO	1.7	2.0	2.5	2.8	3.3	3.6	4.0
OLDHAM	1.6	1.9	2.3	2.7	3.1	3.4	3.7
OWEN	1.5	1.8	2.3	2.6	3.1	3.3	3.7
OWSLEY	1.6	1.9	2.3	2.7	3.2	3.4	3.7
PENDLETON	1.5	1.8	2.2	2.6	3.1	3.3	3.6
PERRY	1.5	1.9	2.3	2.8	3.2	3.4	3.8
PIKE	1.5	1.9	2.3	2.7	3.1	3.4	3.8
POWELL	1.5	1.8	2.3	2.7	3.1	3.4	3.7
PULASKIE	1.6	1.9	2.4	2.8	3.3	3.5	3.8
ROBERTSON	1.5	1.8	2.2	2.6	3.0	3.3	3.6
ROCKCASTLE	1.6	1.9	2.4	2.7	3.2	3.4	3.8
ROWAN	1.5	1.8	2.2	2.6	3.0	3.3	3.6
RUSSELL	1.6	2.0	2.4	2.8	3.3	3.5	3.9
SCOTT	1.6	2.0	2.3	2.6	3.1	3.4	3.6
SHELBY	1.6	1.9	2.3	2.7	3.2	3.4	3.7
SIMPSON	1.7	2.0	2.5	2.9	3.4	3.7	4.0
SPENCER	1.6	1.9	2.4	2.7	3.2	3.4	3.8
TAYLOR	1.6	1.9	2.4	2.8	3.3	3.5	3.8
TODD	1.8	2.1	2.6	2.9	3.4	3.7	4.1
TRIGG	1.8	2.1	2.6	2.9	3.4	3.8	4.2
TRIMBLE	1.6	1.9	2.3	2.7	3.1	3.4	3.7
UNION	1.8	2.1	2.6	2.9	3.3	3.7	4.1
WARREN	1.7	2.0	2.5	2.8	3.3	3.6	4.0
WASHINGTON	1.6	1.9	2.4	2.7	3.2	3.5	3.8
WAYNE	1.6	2.0	2.4	2.8	3.3	3.5	3.9
WEBSTER	1.8	2.1	2.6	2.9	3.3	3.7	4.1
WHITLEY	1.6	1.9	2.4	2.8	3.3	3.5	3.9
WOLFE	1.5	1.9	2.3	2.7	3.1	3.4	3.7
WOODFORD	1.6	1.9	2.3	2.7	3.1	3.4	3.7

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)

6 HOUR RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	1	2	5	10	25	50	100	PMP
ADAIR	2.0	2.3	2.9	3.4	3.8	4.4	4.6	28.7
ALLEN	2.1	2.4	3.0	3.5	3.9	4.5	4.7	28.9
ANDERSON	1.9	2.2	2.8	3.2	3.7	4.2	4.4	28.1
BALLARD	2.2	2.6	3.2	3.7	4.2	4.7	5.1	28.7
BARREN	2.1	2.4	3.0	3.4	3.9	4.4	4.7	28.8
BATH	1.8	2.1	2.7	3.1	3.6	4.0	4.3	28.0
BELL	1.9	2.4	2.9	3.3	3.9	4.4	4.7	28.9
BOONE	1.9	2.2	2.7	3.1	3.5	4.0	4.2	27.5
BOURBON	1.9	2.2	2.7	3.2	3.6	4.0	4.3	28.0
BOYD	1.8	2.1	2.5	3.0	3.6	3.8	4.2	27.9
BOYLE	2.0	2.3	2.8	3.3	3.7	4.2	4.5	28.4
BRACKEN	1.8	2.1	2.7	3.1	3.5	3.9	4.2	27.7
BREATHITT	1.9	2.2	2.7	3.2	3.7	4.0	4.5	28.4
BRECKINRIDGE	2.0	2.4	2.9	3.4	3.8	4.3	4.6	28.3
BULLITT	2.0	2.3	2.9	3.3	3.7	4.2	4.5	28.2
BUTLER	2.1	2.4	3.0	3.5	3.9	4.4	4.7	28.7
CALDWELL	2.2	2.5	3.1	3.6	4.0	4.5	4.9	28.7
CALLOWAY	2.2	2.6	3.2	3.7	4.1	4.7	5.0	29.0
CAMPBELL	1.8	2.1	2.7	3.1	3.5	3.9	4.2	27.5
CARLISLE	2.2	2.6	3.3	3.7	4.2	4.7	5.1	28.9
CARROLL	1.9	2.2	2.7	3.2	3.6	4.0	4.3	27.7
CARTER	1.8	2.1	2.6	3.0	3.6	3.9	4.2	27.9
CASEY	2.0	2.3	2.9	3.3	3.8	4.3	4.5	28.6
CHRISTIAN	2.2	2.5	3.1	3.6	4.0	4.6	4.9	28.9
CLARK	1.9	2.2	2.7	3.2	3.7	4.1	4.3	28.1
CLAY	1.9	2.3	2.8	3.2	3.8	4.2	4.6	28.6
CLINTON	2.0	2.4	3.0	3.4	3.9	4.4	4.7	28.9
CRITTENDEN	2.2	2.5	3.1	3.6	4.0	4.5	4.9	28.6
CUMBERLAND	2.0	2.4	3.0	3.4	3.9	4.4	4.7	28.9
DAVIESS	2.1	2.4	3.0	3.4	3.9	4.4	4.7	28.3
EDMONSON	2.1	2.4	3.0	3.4	3.9	4.4	4.7	28.7
ELLIOTT	1.8	2.1	2.6	3.1	3.6	3.9	4.3	28.0
ESTILL	1.9	2.2	2.7	3.2	3.7	4.1	4.4	28.3
FAYETTE	1.9	2.2	2.8	3.2	3.7	4.1	4.4	28.1
FLEMING	1.8	2.1	2.6	3.1	3.6	3.9	4.2	27.9
FLOYD	1.8	2.2	2.7	3.1	3.8	3.9	4.5	28.4
FRANKLIN	1.9	2.2	2.8	3.2	3.6	4.1	4.4	28.0
FULTON	2.3	2.6	3.3	3.8	4.2	4.8	5.1	29.0
GALLATIN	1.9	2.2	2.7	3.2	3.5	4.0	4.3	27.7
GARRARD	1.9	2.2	2.8	3.2	3.7	4.2	4.4	28.3

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
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6 HOUR RAINFALL (INCHES)

	FREQUENCY (YEARS)							
COUNTY	1	2	5	10	25	50	100	PMP
GRANT	1.9	2.2	2.7	3.1	3.5	4.0	4.3	27.7
GRAVES	2.2	2.6	3.3	3.7	4.1	4.7	5.0	28.9
GRAYSON	2.1	2.4	3.0	3.4	3.9	4.4	4.7	28.5
GREEN	2.0	2.3	2.9	3.4	3.8	4.3	4.6	28.6
GREENUP	1.8	2.1	2.5	3.0	3.5	3.8	4.1	27.7
HANCOCK	2.1	2.4	3.0	3.4	3.9	4.3	4.7	28.2
HARDIN	2.0	2.3	2.9	3.4	3.8	4.3	4.6	28.3
HARLAN	1.9	2.3	2.8	3.3	3.8	4.3	4.7	28.8
HARRISON	1.9	2.2	2.7	3.1	3.6	4.0	4.3	27.9
HART	2.0	2.3	2.9	3.4	3.9	4.4	4.6	28.6
HENDERSON	2.1	2.5	3.0	3.5	4.0	4.4	4.8	28.3
HENRY	1.9	2.2	2.8	3.2	3.6	4.1	4.4	27.9
HICKMAN	2.3	2.6	3.3	3.7	4.2	4.7	5.1	29.0
HOPKINS	2.1	2.5	3.1	3.5	4.0	4.5	4.8	28.6
JACKSON	1.9	2.3	2.8	3.2	3.8	4.2	4.5	28.5
JEFFERSON	2.0	2.3	2.8	3.3	3.7	4.2	4.5	28.0
JESSAMINE	1.9	2.2	2.8	3.2	3.7	4.1	4.4	28.2
JOHNSON	1.8	2.2	2.6	3.1	3.7	3.9	4.4	28.2
KENTON	1.8	2.1	2.7	3.1	3.5	3.9	4.2	27.5
KNOTT	1.9	2.2	2.7	3.2	3.8	4.0	4.5	28.5
KNOX	1.9	2.3	2.9	3.3	3.8	4.4	4.7	28.8
LARUE	2.0	2.3	2.9	3.4	3.8	4.3	4.6	28.4
LAUREL	1.9	2.3	2.8	3.3	3.8	4.3	4.6	28.7
LAWRENCE	1.8	2.1	2.6	3.0	3.6	3.9	4.3	28.1
LEE	1.9	2.2	2.7	3.2	3.7	4.1	4.4	28.4
LESLIE	1.9	2.3	2.8	3.3	3.8	4.2	4.6	28.7
LETCHER	1.9	2.3	2.8	3.2	3.8	4.1	4.6	28.6
LEWIS	1.8	2.1	2.6	3.0	3.5	3.9	4.2	27.8
LINCOLN	2.0	2.3	2.8	3.3	3.8	4.3	4.5	28.5
LIVINGTON	2.2	2.5	3.2	3.6	4.1	4.6	5.0	28.6
LOGAN	2.1	2.4	3.1	3.5	4.0	4.5	4.8	28.9
LYON	2.2	2.5	3.2	3.6	4.1	4.6	4.9	28.8
MCCRACKEN	2.2	2.6	3.2	3.7	4.1	4.6	5.0	28.7
MCCREARY	2.0	2.4	2.9	3.4	3.9	4.4	4.7	28.9
MCCLEAN	2.1	2.4	3.0	3.5	3.9	4.4	4.8	28.5
MADISON	1.9	2.2	2.8	3.2	3.7	4.2	4.4	28.3
MAGOFFIN	1.8	2.2	2.7	3.1	3.7	4.0	4.4	28.3
MARION	2.0	2.3	2.9	3.3	3.8	4.3	4.5	28.4
MARSHALL	2.2	2.6	3.2	3.7	4.1	4.6	5.0	28.8
MARTIN	1.8	2.1	2.6	3.0	3.7	3.9	4.4	28.2

DIVISION OF WATER RESOURCES
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6 HOUR RAINFALL (INCHES)

	FREQUENCY (YEARS)							
COUNTY	1	2	5	10	25	50	100	PMP
MASON	1.8	2.1	2.6	3.1	3.5	3.9	4.2	27.7
MEADE	2.0	2.3	2.9	3.3	3.8	4.3	4.6	28.2
MENIFEE	1.9	2.2	2.7	3.1	3.7	4.0	4.3	28.2
MERCER	1.9	2.2	2.8	3.3	3.7	4.2	4.4	28.3
METCALFE	2.0	2.4	3.0	3.4	3.9	4.4	4.7	28.8
MONROE	2.1	2.4	3.0	3.5	3.9	4.5	4.7	28.9
MONGOMERY	1.9	2.2	2.7	3.1	3.6	4.0	4.3	28.1
MORGAN	1.8	2.2	2.7	3.1	3.7	4.0	4.3	28.2
MUHLENBERG	2.1	2.5	3.1	3.5	4.0	4.5	4.8	28.6
NELSON	2.0	2.3	2.9	3.3	3.8	4.2	4.5	28.3
NICHOLAS	1.8	2.1	2.7	3.1	3.6	4.0	4.3	27.9
OHIO	2.1	2.4	3.0	3.4	3.9	4.4	4.7	28.5
OLDHAM	1.9	2.3	2.8	3.2	3.6	4.1	4.4	27.9
OWEN	1.9	2.2	2.7	3.2	3.6	4.0	4.3	27.8
OWSLEY	1.9	2.2	2.8	3.2	3.7	4.1	4.5	28.5
PENDLETON	1.8	2.1	2.7	3.1	3.5	4.0	4.2	27.7
PERRY	1.7	2.3	2.8	3.2	3.8	4.1	4.6	28.6
PIKE	1.8	2.2	2.7	3.1	3.8	4.0	4.5	28.4
POWELL	1.9	2.2	2.7	3.2	3.7	4.1	4.4	28.2
PULASKI	2.0	2.3	2.9	3.3	3.8	4.3	4.6	28.7
ROBERTSON	1.8	2.1	2.7	3.1	3.5	4.0	4.2	27.8
ROCKCASTLE	1.9	2.3	2.8	3.3	3.8	4.2	4.5	28.5
ROWAN	1.8	2.1	2.6	3.1	3.6	3.9	4.3	28.0
RUSSELL	2.0	2.3	2.9	3.4	3.7	4.4	4.6	28.8
SCOTT	1.9	2.2	2.7	3.2	3.6	4.1	4.3	27.9
SHELBY	1.9	2.2	2.8	3.2	3.7	4.1	4.4	28.0
SIMPSON	2.1	2.4	3.1	3.5	4.0	4.5	4.8	28.9
SPENCER	2.0	2.3	2.8	3.3	3.7	4.2	4.4	28.1
TAYLOR	2.0	2.3	2.9	3.4	3.8	4.3	4.5	28.5
TODD	2.2	2.5	3.1	3.5	4.0	4.6	4.8	28.9
TRIGG	2.2	2.5	3.1	3.6	4.1	4.3	4.9	28.9
TRIMBLE	1.9	2.2	2.8	3.2	3.6	4.1	4.4	27.8
UNION	2.1	2.5	3.1	3.5	4.0	4.5	4.8	28.4
WARREN	2.1	2.4	3.0	3.5	3.9	4.5	4.7	28.8
WASHINGTON	2.0	2.3	2.8	3.3	3.7	4.2	4.5	28.3
WAYNE	2.0	2.4	2.9	3.4	3.9	4.4	4.7	28.9
WEBSTER	2.1	2.5	3.1	3.5	4.0	4.5	4.8	28.5
WHITLEY	2.0	2.4	2.9	3.4	3.9	4.4	4.7	28.9
WOLFE	1.9	2.2	2.7	3.1	3.7	4.0	4.4	28.3
WOODFORD	1.9	2.2	2.8	3.2	3.7	4.1	4.4	28.1

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)

12 HOUR RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	1	2	5	10	25	50	100	PMP
ADAIR	2.4	2.8	3.5	4.0	4.5	5.1	5.5	33.8
ALLEN	2.5	2.9	3.7	4.2	4.6	5.3	5.7	34.2
ANDERSON	2.3	2.7	3.4	3.8	4.3	4.8	5.3	33.1
BALLARD	2.7	3.1	3.8	4.4	4.9	5.6	6.0	34.1
BARREN	2.5	2.9	3.6	4.1	4.6	5.2	5.6	33.9
BATH	2.2	2.6	3.2	3.6	4.2	4.6	5.2	32.6
BELL	2.4	2.8	3.4	3.9	4.5	4.9	5.6	34.2
BOONE	2.2	2.6	3.2	3.6	4.1	4.6	5.1	32.1
BOURBON	2.2	2.6	3.2	3.7	4.2	4.7	5.2	33.0
BOYD	2.1	2.5	3.0	3.5	4.0	4.4	5.0	32.5
BOYLE	2.3	2.7	3.4	3.9	4.4	4.9	5.4	33.3
BRACKEN	2.2	2.6	3.1	3.6	4.1	4.5	5.1	32.3
BREATHITT	2.2	2.6	3.2	3.7	4.2	4.7	5.3	33.5
BRECKINRIDGE	2.4	2.8	3.6	4.0	4.5	5.1	5.5	33.4
BULLITT	2.4	2.8	3.5	3.9	4.4	4.9	5.4	33.2
BUTLER	2.5	2.9	3.6	4.1	4.6	5.3	5.7	33.7
CALDWELL	2.6	3.0	3.7	4.3	4.8	5.4	5.8	34.0
CALLOWAY	2.7	3.1	3.8	4.4	4.9	5.6	6.0	34.4
CAMPBELL	2.2	2.6	3.0	3.6	4.1	4.5	5.1	32.1
CARLISLE	2.7	3.1	3.8	4.4	4.9	5.7	6.1	34.3
CARROLL	2.3	2.7	3.3	3.7	4.2	4.7	5.2	32.4
CARTER	2.1	2.5	3.0	3.5	4.0	4.4	5.0	32.6
CASEY	2.4	2.8	3.5	3.9	4.5	5.0	5.5	33.7
CHRISTIAN	2.6	3.0	3.7	4.3	4.7	5.5	5.8	34.2
CLARK	2.3	2.7	3.3	3.7	4.3	4.7	5.3	33.1
CLAY	2.3	2.7	3.3	3.8	4.4	4.8	5.4	33.8
CLINTON	2.5	2.9	3.6	4.1	4.6	5.2	5.6	34.2
CRITTENDEN	2.6	3.0	3.7	4.3	4.8	5.4	5.8	33.7
CUMBERLAND	2.5	2.9	3.6	4.1	4.6	5.2	5.6	34.2
DAVIESS	2.5	2.9	3.6	4.1	4.6	5.2	5.6	33.5
EDMONSON	2.5	2.9	3.7	4.1	4.6	5.2	5.6	33.8
ELLIOTT	2.1	2.5	3.1	3.6	4.1	4.5	5.1	32.9
ESTILL	2.3	2.7	3.3	3.7	4.3	4.8	5.3	33.4
FAYETTE	2.3	2.7	3.3	3.8	4.3	4.7	5.3	33.1
FLEMING	2.2	2.6	3.1	3.6	4.1	4.5	5.1	32.6
FLOYD	2.2	2.6	3.2	3.7	4.2	4.6	5.2	33.5
FRANKLIN	2.3	2.7	3.3	3.8	4.3	4.8	5.3	33.0
FULTON	2.7	3.2	3.9	4.4	5.0	5.8	6.2	34.5
GALLATIN	2.2	2.6	3.2	3.7	4.2	4.6	5.2	32.3
GARRARD	2.3	2.7	3.4	3.8	4.3	4.9	5.4	33.5

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
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12 HOUR RAINFALL (INCHES)

	FREQUENCY (YEARS)							
COUNTY	1	2	5	10	25	50	100	PMP
GRANT	2.2	2.6	3.2	3.7	4.2	4.6	5.2	32.2
GRAVES	2.7	3.1	3.8	4.4	4.9	5.7	6.0	34.4
GRAYSON	2.5	2.9	3.6	4.1	4.5	5.2	5.6	33.5
GREEN	2.4	2.8	3.5	4.0	4.5	5.1	5.5	33.7
GREENUP	2.1	2.5	3.0	3.5	4.0	4.4	5.0	32.4
HANCOCK	2.5	2.9	3.6	4.1	4.5	5.1	5.6	33.3
HARDIN	2.4	2.8	3.5	4.0	4.5	5.1	5.5	33.4
HARLAN	2.3	2.7	3.4	3.8	4.4	4.9	5.5	34.0
HARRISON	2.2	2.6	3.2	3.7	4.2	4.6	5.2	32.6
HART	2.5	2.8	3.6	4.1	4.5	5.2	5.5	33.7
HENDERSON	2.5	2.9	3.6	4.1	4.6	5.3	5.7	33.5
HENRY	2.3	2.7	3.3	3.8	4.3	4.8	5.3	32.6
HICKMAN	2.7	3.1	3.9	4.4	4.9	5.7	6.1	34.4
HOPKINS	2.6	3.0	3.7	4.2	4.7	5.4	5.8	33.8
JACKSON	2.3	2.7	3.3	3.8	4.3	4.8	5.4	33.5
JEFFERSON	2.4	2.8	3.4	3.9	4.4	4.9	5.4	33.0
JESSAMINE	2.3	2.7	3.3	3.8	4.3	4.8	5.3	33.3
JOHNSON	2.2	2.5	3.1	3.6	4.1	4.5	5.1	33.1
KENTON	2.2	2.6	3.2	3.6	4.1	4.5	5.1	32.1
KNOTT	2.2	2.6	3.2	3.7	4.2	4.7	5.3	33.8
KNOX	2.4	2.8	3.4	3.9	4.4	4.9	5.5	34.0
LARUE	2.4	2.8	3.5	4.0	4.5	5.1	5.5	33.5
LAUREL	2.4	2.8	3.4	3.9	4.4	4.9	5.5	33.8
LAWRENCE	2.1	2.5	3.0	3.5	4.0	4.5	5.1	32.9
LEE	2.3	2.7	3.3	3.7	4.3	4.7	5.3	33.5
LESLIE	2.3	2.7	3.3	3.8	4.3	4.8	5.4	33.8
LETCHER	2.3	2.6	3.3	3.7	4.3	4.7	5.4	33.8
LEWIS	2.1	2.5	3.0	3.5	4.0	4.4	5.0	32.4
LINCOLN	2.3	2.7	3.4	3.9	4.4	4.9	5.4	33.5
LIVINGSTON	2.6	3.0	3.8	4.3	4.8	5.5	5.9	34.0
LOGAN	2.6	2.9	3.7	4.2	4.7	5.4	5.7	34.2
LYON	2.6	3.0	3.8	4.3	4.8	5.5	5.9	34.1
MCCRACKEN	2.6	3.1	3.8	4.4	4.9	5.6	6.0	34.1
MCCREARY	2.4	2.8	3.5	4.0	4.5	5.1	5.6	34.1
MCLEAN	2.5	2.9	3.7	4.2	4.6	5.3	5.7	33.6
MADISON	2.3	2.7	3.3	3.8	4.3	4.8	5.3	33.3
MAGOFFIN	2.2	2.6	3.2	3.6	4.2	4.6	5.2	33.4
MARION	2.4	2.8	3.5	3.9	4.4	5.0	5.4	33.5
MARSHALL	2.6	3.1	3.8	4.3	4.8	5.6	5.9	34.2
MARTIN	2.1	2.5	3.1	3.6	4.0	4.5	5.1	33.1

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)

12 HOUR RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	1	2	5	10	25	50	100	PMP
MASON	2.1	2.6	3.1	3.6	4.1	4.5	5.1	32.3
MEADE	2.4	2.8	3.5	4.0	4.5	5.0	5.5	33.2
MENIFEE	2.2	2.6	3.2	3.6	4.2	4.6	5.2	33.1
MERCER	2.3	2.7	3.4	3.9	4.4	4.9	5.4	33.2
METCALFE	2.5	2.9	3.6	4.1	4.6	5.2	5.6	33.9
MONROE	2.5	2.9	3.6	4.1	4.6	5.3	5.7	34.2
MONTGOMERY	2.2	2.6	3.2	3.7	4.2	4.6	5.2	33.1
MORGAN	2.2	2.6	3.1	3.6	4.1	4.6	5.2	33.2
MUHLENBERG	2.5	2.9	3.7	4.2	4.7	5.3	5.7	33.8
NELSON	2.4	2.8	3.5	3.9	4.4	5.0	5.4	33.3
NICHOLAS	2.2	2.6	3.2	3.6	4.2	4.6	5.2	32.6
OHIO	2.5	2.9	3.6	4.1	4.6	5.2	5.6	33.6
OLDHAM	2.3	2.7	3.4	3.8	4.3	4.8	5.3	32.9
OWEN	2.2	2.7	3.3	3.7	4.2	4.7	5.2	32.5
OWSLEY	2.3	2.7	3.3	3.8	4.3	4.8	5.3	33.5
PENDLETON	2.2	2.6	3.2	3.6	4.2	4.6	5.2	32.2
PERRY	2.3	2.7	3.3	3.7	1.3	4.8	5.4	33.7
PIKE	2.2	2.5	3.2	3.7	4.1	4.6	5.2	33.5
POWELL	2.2	2.6	3.2	3.7	4.2	4.7	5.3	33.3
PULASKI	2.4	2.8	3.5	3.9	4.5	5.0	5.5	33.8
ROBERTSON	2.2	2.6	3.1	3.6	4.1	4.5	5.1	32.4
ROCKCASTLE	2.3	2.7	3.4	3.8	4.4	4.9	5.4	33.5
ROWAN	2.2	2.6	3.1	3.6	4.1	4.5	5.1	32.6
RUSSELL	2.4	2.8	3.5	4.0	4.5	5.1	5.5	33.9
SCOTT	2.3	2.7	3.3	3.7	4.2	4.7	5.2	32.8
SHELBY	2.3	2.7	3.4	3.8	4.3	4.8	5.3	33.0
SIMPSON	2.6	2.9	3.7	4.2	4.7	5.4	5.7	34.2
SPENCER	2.3	2.7	3.4	3.9	4.4	4.9	5.4	33.1
TAYLOR	2.4	2.8	3.5	4.0	4.5	5.0	5.5	33.6
TODD	2.6	3.0	3.7	4.2	4.7	5.4	5.8	34.2
TRIGG	2.6	3.0	3.8	4.3	4.8	5.5	5.9	34.2
TRIMBLE	2.3	2.7	3.3	3.8	4.3	4.8	5.3	32.4
UNION	2.6	3.0	3.7	4.3	4.7	5.3	5.8	33.5
WARREN	2.5	2.9	3.6	4.1	4.6	5.3	5.7	33.9
WASHINGTON	2.4	2.8	3.4	3.9	4.4	4.9	5.4	33.3
WAYNE	2.4	2.8	3.5	4.0	4.6	5.1	5.6	34.1
WEBSTER	2.6	3.0	3.7	4.2	4.7	5.3	5.8	33.5
WHITLEY	2.4	2.8	3.5	3.9	4.5	5.0	5.6	34.1
WOLFE	2.2	2.6	3.2	3.7	4.2	4.7	5.2	33.2
WOODFORD	2.3	2.7	3.3	3.8	4.3	4.8	5.3	33.1

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
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24 HOUR RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	1	2	5	10	25	50	100	PMP
ADAIR	2.8	3.3	4.1	4.6	5.4	5.9	6.4	36.5
ALLEN	2.8	3.4	4.3	4.8	5.6	6.1	6.6	37.0
ANDERSON	2.7	3.1	3.9	4.4	5.2	5.6	6.2	35.0
BALLARD	3.1	3.6	4.5	5.1	5.8	6.5	7.0	36.5
BARREN	2.8	3.3	4.2	4.7	5.5	6.0	6.5	36.5
BATH	2.5	3.0	3.7	4.2	4.9	5.4	5.9	35.0
BELL	2.6	3.1	3.9	4.5	5.2	5.8	6.3	37.0
BOONE	2.6	3.0	3.7	4.2	4.9	5.4	5.9	34.0
BOURBON	2.6	3.0	3.8	4.3	5.0	5.4	6.0	35.0
BOYD	2.5	2.7	3.5	4.0	4.6	5.0	5.5	35.0
BOYLE	2.7	3.2	4.0	4.5	5.2	5.7	6.3	35.5
BRACKEN	2.5	3.0	3.7	4.2	4.9	5.3	5.8	34.5
BREATHITT	2.6	3.0	3.7	4.3	4.9	5.4	5.9	36.0
BRECKINRIDGE	2.8	3.3	4.1	4.6	5.4	5.9	6.4	35.5
BULLITT	2.7	3.2	4.0	4.5	5.2	5.7	6.3	35.5
BUTLER	2.9	3.4	4.2	4.8	5.5	6.1	6.6	36.0
CALDWELL	3.0	3.4	4.3	4.9	5.6	6.3	6.8	36.5
CALLOWAY	3.1	3.5	4.4	5.0	5.8	6.5	6.9	37.0
CAMPBELL	2.5	3.0	3.7	4.2	4.9	5.3	5.8	34.0
CARLISLE	3.1	3.6	4.5	5.1	5.8	6.5	7.0	37.0
CARROLL	2.6	3.1	3.8	4.3	5.1	5.5	6.1	34.5
CARTER	2.5	2.8	3.6	4.0	4.7	5.1	5.6	35.0
CASEY	2.7	3.2	4.0	4.5	5.3	5.8	6.3	36.0
CHRISTIAN	3.0	3.4	4.3	4.9	5.7	6.3	6.8	36.5
CLARK	2.6	3.0	3.8	4.3	5.0	5.5	6.1	35.5
CLAY	2.6	3.0	3.8	4.4	5.1	5.6	6.2	36.5
CLINTON	2.8	3.3	4.2	4.7	5.5	6.0	6.5	37.0
CRITTENDEN	3.0	3.5	4.3	4.7	5.6	6.3	6.8	36.0
CUMBERLAND	2.8	3.3	4.2	4.7	5.5	6.0	6.5	37.0
DAVIESS	2.8	3.3	4.2	4.7	5.5	6.0	6.5	35.5
EDMONSON	2.8	3.3	4.2	4.7	5.5	6.0	6.5	36.0
ELLIOTT	2.5	2.8	3.6	4.1	4.7	5.2	5.7	35.5
ESTILL	2.6	3.0	3.8	4.3	5.0	5.5	6.1	35.5
FAYETTE	2.6	3.1	3.8	4.3	5.1	5.5	6.1	35.5
FLEMING	2.5	2.9	3.6	4.1	4.8	5.3	5.8	35.0
FLOYD	2.5	2.9	3.7	4.2	4.8	5.3	5.7	36.0
FRANKLIN	2.6	3.1	3.9	4.4	5.1	5.5	6.1	35.0
FULTON	3.1	3.7	4.5	5.2	5.9	6.6	7.1	37.5
GALLATIN	2.6	3.1	3.8	4.3	5.0	5.4	6.0	34.5
GARRARD	2.6	3.1	3.9	4.4	5.2	5.6	6.2	36.0

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24 HOUR RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	1	2	5	10	25	50	100	PMP
GRANT	2.6	3.1	3.7	4.2	5.0	5.4	6.0	34.5
GRAVES	3.1	3.6	4.5	5.1	5.8	6.5	7.0	37.0
GRAYSON	2.8	3.3	4.2	4.7	5.5	6.0	6.2	36.0
GREEN	2.8	3.3	4.1	4.6	5.4	5.9	6.4	36.0
GREENUP	2.5	2.8	3.5	4.0	4.6	5.0	5.5	35.0
HANCOCK	2.8	3.3	4.1	4.7	5.4	6.0	6.5	35.5
HARDIN	2.7	3.2	4.1	4.6	5.3	5.9	6.4	35.5
HARLAN	2.6	3.0	3.8	4.4	5.1	5.7	6.1	37.0
HARRISON	2.6	3.0	3.7	4.2	5.0	5.4	6.0	35.0
HART	2.8	3.3	4.1	4.6	5.4	5.9	6.4	36.0
HENDERSON	2.9	3.4	4.2	4.8	5.5	6.1	6.6	35.5
HENRY	2.6	3.1	3.9	4.4	5.1	5.5	6.1	34.5
HICKMAN	3.1	3.6	4.5	5.2	5.9	6.6	7.0	37.0
HOPKINS	2.9	3.4	4.3	4.8	5.5	6.2	6.7	36.0
JACKSON	2.9	3.1	3.8	4.4	5.1	5.6	6.2	36.0
JEFFERSON	2.7	3.2	4.0	4.5	5.2	5.7	6.2	35.0
JESSAMINE	2.6	3.1	3.9	4.4	5.1	5.5	6.2	35.5
JOHNSON	2.5	2.8	3.6	4.1	4.7	5.2	5.7	35.5
KENTON	2.5	3.0	3.7	4.2	4.9	5.3	5.8	34.0
KNOTT	2.5	2.9	3.7	4.3	4.9	5.5	5.9	36.5
KNOX	2.6	3.1	3.9	4.5	5.2	5.8	6.3	37.0
LARUE	2.7	3.2	4.1	4.6	5.3	5.8	6.4	35.5
LAUREL	2.6	3.1	3.9	4.5	5.2	5.7	6.3	36.5
LAWRENCE	2.5	2.8	3.6	4.0	4.7	5.1	5.6	35.5
LEE	2.6	3.0	3.8	4.3	5.0	5.5	6.1	36.0
LESLIE	2.6	3.0	3.8	4.4	5.0	5.6	6.1	36.5
LETCHER	2.5	2.9	3.7	4.3	4.9	5.6	5.9	36.5
LEWIS	2.5	2.8	3.6	4.0	4.7	5.1	5.6	35.0
LINCOLN	2.7	3.2	3.9	4.5	5.2	5.7	6.3	36.0
LIVINGSTON	3.0	3.5	4.4	4.9	5.7	6.1	6.9	36.0
LOGAN	2.9	3.4	4.3	4.8	5.6	6.2	6.7	36.5
LYON	3.0	3.5	4.4	4.9	5.7	6.4	6.8	36.5
MCCRACKEN	3.0	3.6	4.4	5.0	5.8	6.4	6.9	36.5
MCREARY	2.7	3.2	4.0	4.6	5.3	5.9	6.4	37.0
MCLEAN	2.9	3.4	4.2	4.8	5.5	6.1	6.6	35.5
MADISON	2.6	3.1	3.8	4.3	5.1	5.6	6.1	35.5
MAGOFFIN	2.5	2.9	3.7	4.2	4.8	5.3	5.8	36.0
MARION	2.7	3.2	4.0	4.5	5.3	5.8	6.3	36.0
MARSHALL	3.0	3.5	4.4	5.0	5.7	6.4	6.9	37.0
MARTIN	2.5	2.8	3.6	4.1	4.7	5.2	5.6	36.0

DIVISION OF WATER RESOURCES
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24 HOUR RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	1	2	5	10	25	50	100	PMP
MASON	2.5	2.9	3.6	4.1	4.8	5.3	5.8	34.5
MEADE	2.7	3.2	4.1	4.6	5.3	5.8	6.4	35.0
MENIFEE	2.5	2.9	3.7	4.2	4.9	5.4	5.9	35.5
MERCER	2.7	3.2	3.9	4.4	5.2	5.6	6.2	35.5
METCALFE	2.8	3.3	4.2	4.7	5.5	6.0	6.5	36.5
MONROE	2.8	3.4	4.2	4.7	5.6	6.0	6.6	37.0
MONTGOMERY	2.6	3.0	3.7	4.2	5.0	5.4	6.0	35.5
MORGAN	2.5	2.9	3.7	4.1	4.8	5.3	5.8	35.5
MUHLENBERG	2.9	3.4	4.3	4.8	5.5	6.2	6.7	36.0
NELSON	2.7	3.2	4.0	4.5	5.3	5.7	6.3	35.5
NICHOLAS	2.6	3.0	3.7	4.2	4.9	5.4	5.9	35.0
OHIO	2.8	3.3	4.2	4.7	5.5	6.0	6.5	36.0
OLDHAM	2.7	3.2	3.9	4.4	5.2	5.6	6.2	34.5
OWEN	2.6	3.1	3.8	4.3	5.1	5.5	6.1	34.5
OWSLEY	2.6	3.1	3.8	4.3	5.1	5.5	6.1	36.5
PENDLETON	2.6	3.1	3.7	4.2	4.9	5.3	5.9	34.5
PERRY	2.5	3.0	3.8	4.3	5.0	5.5	6.0	36.5
PIKE	2.5	2.9	3.6	4.2	4.8	5.4	5.7	36.5
POWELL	2.6	3.0	3.8	4.3	5.0	5.5	6.0	35.5
PULASKI	2.7	3.2	4.0	4.5	5.3	5.8	6.3	36.5
ROBERTSON	2.5	3.0	3.7	4.2	4.9	5.3	5.9	34.5
ROCKCASTLE	2.6	3.1	3.9	4.4	5.2	5.7	6.2	36.0
ROWAN	2.5	2.9	3.6	4.1	4.8	5.3	5.8	35.0
RUSSELL	2.8	3.3	4.1	4.6	5.4	5.9	6.4	36.5
SCOTT	2.6	3.1	3.8	4.3	5.1	5.5	6.1	35.0
SHELBY	2.7	3.2	3.9	4.4	5.2	5.6	6.2	35.0
SIMPSON	2.9	3.4	4.3	4.8	5.6	6.1	6.7	37.0
SPENCER	2.7	3.2	4.0	4.5	5.2	5.6	6.2	35.0
TAYLOR	2.7	3.2	4.1	4.6	5.3	5.8	6.4	36.0
TODD	2.9	3.4	4.3	4.9	5.6	6.3	6.7	36.5
TRIGG	3.0	3.5	4.4	5.0	5.7	6.4	6.8	37.0
TRIMBLE	2.6	3.1	3.9	4.4	5.1	5.5	6.1	34.5
UNION	2.9	3.4	4.3	4.8	5.5	6.2	6.7	35.5
WARREN	2.9	3.4	4.2	4.8	5.5	6.1	6.6	36.5
WASHINGTON	2.7	3.2	4.0	4.5	5.2	5.7	6.3	35.5
WAYNE	2.8	3.3	4.1	4.6	5.4	5.9	6.4	37.0
WEBSTER	2.9	3.4	4.3	4.8	5.5	6.2	6.7	36.0
WHITLEY	2.7	3.2	4.0	4.5	5.3	5.9	6.4	37.0
WOLFE	2.5	2.9	3.7	4.2	4.9	5.4	5.9	36.0
WOODFORD	2.6	3.1	3.9	4.4	5.1	5.6	6.2	35.0

DIVISION OF WATER RESOURCES
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ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)

2 DAY RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	1	2	5	10	25	50	100	PMP
ADAIR	0.0	3.8	4.6	5.3	6.3	6.7	7.5	40.0
ALLEN	0.0	3.9	4.8	5.5	6.5	7.0	7.8	40.5
ANDERSON	0.0	3.6	4.4	5.1	6.0	6.4	7.2	39.0
BALLARD	0.0	4.2	5.2	5.9	4.8	7.6	8.3	40.5
BARREN	0.0	3.9	4.7	5.5	6.4	6.9	7.7	40.0
BATH	0.0	3.4	4.1	4.9	5.6	6.1	6.9	39.0
BELL	0.0	3.6	4.5	5.1	6.0	6.7	7.3	41.0
BOONE	0.0	3.4	4.1	4.8	5.6	6.0	6.8	38.0
BOURBON	0.0	3.5	4.2	4.9	5.7	6.1	7.0	38.5
BOYD	0.0	3.2	3.9	4.6	5.2	5.8	6.4	38.5
BOYLE	0.0	3.6	4.4	5.2	6.1	6.5	7.3	39.5
BRACKEN	0.0	3.4	4.1	4.8	5.5	6.0	6.8	38.0
BREATHITT	0.0	3.4	4.2	4.9	5.6	6.3	6.9	39.5
BRECKINRIDGE	0.0	3.8	4.6	5.3	6.3	6.7	7.5	39.0
BULLITT	0.0	3.7	4.5	5.2	6.2	6.5	7.3	39.0
BUTLER	0.0	3.9	4.8	5.5	6.4	6.9	7.7	40.0
CALDWELL	0.0	4.0	5.0	5.7	6.6	7.2	7.9	40.0
CALLOWAY	0.0	4.1	5.1	5.9	6.8	7.6	8.2	41.0
CAMPBELL	0.0	3.4	4.1	4.7	5.5	6.0	6.8	38.0
CARLISLE	0.0	4.2	5.2	6.0	6.8	7.7	8.3	41.0
CARROLL	0.0	3.5	4.2	4.9	5.8	6.2	7.0	38.0
CARTER	0.0	3.2	4.0	4.7	5.3	5.9	6.6	38.5
CASEY	0.0	3.7	4.5	5.2	6.2	6.6	7.4	40.0
CHRISTIAN	0.0	4.0	5.0	5.7	6.6	7.2	7.9	40.5
CLARK	0.0	3.5	4.2	5.0	5.8	6.2	7.1	39.0
CLAY	0.0	3.5	4.4	5.0	5.9	6.5	7.3	40.0
CLINTON	0.0	3.8	4.7	5.6	6.4	6.9	7.6	40.5
CRITTTENDEN	0.0	4.0	5.0	5.7	6.6	7.2	7.9	40.0
CUMBERLAND	0.0	3.8	4.7	5.4	6.4	6.9	7.6	40.5
DAVIESS	0.0	3.8	4.7	5.4	6.4	6.9	7.6	39.5
EDMONSON	0.0	3.8	4.7	5.5	6.4	6.8	7.6	40.0
ELLIOTT	0.0	3.3	4.0	4.7	5.4	6.0	6.7	39.0
ESTILL	0.0	3.5	4.3	5.0	5.8	6.3	7.1	39.5
FAYETTE	0.0	3.5	4.3	5.0	5.9	6.3	7.1	39.0
FLEMING	0.0	3.3	4.0	4.8	5.5	6.0	6.8	38.5
FLOYD	0.0	3.3	4.0	4.8	5.5	6.2	6.7	40.0
FRANKLIN	0.0	3.6	4.2	5.0	5.9	6.3	7.1	38.5
FULTON	0.0	4.3	5.3	6.1	7.0	7.9	8.5	41.0
GALLATIN	0.0	3.5	4.2	4.9	5.7	6.1	7.0	38.0
GARRARD	0.0	3.6	4.4	5.1	6.0	6.4	7.2	39.5

2 DAY RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	1	2	5	10	25	50	100	PMP
GRANT	0.0	3.5	4.2	4.9	5.7	6.1	7.0	38.0
GRAVES	0.0	4.2	5.3	5.9	6.8	7.6	8.3	41.0
GRAYSON	0.0	3.8	4.7	5.4	6.3	6.8	7.6	39.5
GREEN	0.0	3.8	4.6	5.3	6.3	6.7	7.5	40.0
GREENUP	0.0	3.2	3.9	4.6	5.2	5.8	6.4	38.5
HANCOCK	0.0	3.8	4.7	5.4	6.3	6.8	7.6	39.0
HARDIN	0.0	3.7	4.6	5.3	6.3	6.6	7.4	39.5
HARLAN	0.0	3.5	4.4	4.9	5.8	6.6	7.2	41.0
HARRISON	0.0	3.5	4.0	4.9	5.7	6.1	7.0	38.5
HART	0.0	3.8	4.7	5.4	6.3	6.8	7.6	39.5
HENDERSON	0.0	3.9	4.8	5.5	6.4	6.9	7.7	39.0
HENRY	0.0	3.6	4.3	5.0	5.9	6.2	7.1	38.5
HICKMAN	0.0	4.2	5.2	6.0	6.9	7.8	8.4	41.0
HOPKINS	0.0	3.9	4.9	5.6	6.5	7.0	7.8	39.5
JACKSON	0.0	3.5	4.3	5.1	5.9	6.4	7.2	40.0
JEFFERSON	0.0	3.6	4.4	5.1	6.1	6.4	7.3	38.5
JESSAMINE	0.0	3.6	4.3	5.1	6.0	6.2	7.1	39.0
JOHNSON	0.0	3.3	4.0	4.7	5.4	6.0	6.7	39.5
KENTON	0.0	3.4	4.1	4.8	5.5	6.0	6.8	38.0
KNOTT	0.0	3.4	4.1	4.8	5.6	6.3	6.9	40.0
KNOX	0.0	3.6	4.5	5.1	6.0	6.6	7.3	40.5
LARUE	0.0	3.7	4.6	5.3	6.2	6.6	7.4	39.5
LAUREL	0.0	3.6	4.4	5.1	6.0	6.6	7.3	40.0
LAWRENCE	0.0	3.2	3.9	4.7	5.3	6.0	6.5	39.0
LEE	0.0	3.5	4.2	5.0	5.8	6.3	7.0	39.5
LESLIE	0.0	3.5	4.3	5.0	5.8	6.5	7.1	40.5
LETCHER	0.0	3.4	4.2	4.8	5.6	6.4	6.9	40.5
LEWIS	0.0	3.2	4.0	4.7	5.4	5.9	6.6	38.5
LINCOLN	0.0	3.6	4.4	5.2	6.1	6.5	7.3	39.5
LIVINGSTON	0.0	4.0	5.1	5.8	6.7	7.4	8.0	40.0
LOGAN	0.0	3.9	4.9	5.6	6.5	7.0	7.8	40.5
LYON	0.0	4.0	5.0	5.8	6.7	7.3	8.0	40.0
MCCRACKEN	0.0	4.1	5.1	5.9	6.7	7.6	8.2	40.5
MCCREARY	0.0	3.7	4.6	5.3	6.2	6.8	7.5	40.5
MCLEAN	0.0	3.9	4.8	5.5	6.5	6.9	7.7	39.5
MADISON	0.0	3.5	4.3	5.1	5.9	6.3	7.1	39.5
MAGOFFIN	0.0	3.3	4.1	4.8	5.5	6.2	6.8	39.5
MARION	0.0	3.7	4.5	5.2	6.2	6.6	7.4	39.5
MARSHALL	0.0	4.1	5.1	5.9	6.7	7.5	8.1	40.5
MARTIN	0.0	3.2	3.9	4.7	5.3	6.0	6.6	39.5

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)

2 DAY RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	1	2	5	10	25	50	100	PMP
MASON	0.0	3.3	4.0	4.8	5.5	5.9	6.7	38.0
MEADE	0.0	3.7	4.6	5.3	6.2	6.6	7.4	39.0
MENIFEE	0.0	3.4	4.1	4.9	5.6	6.1	6.9	39.0
MERCER	0.0	3.6	4.4	5.1	6.0	6.4	7.2	39.0
METCALFE	0.0	3.8	4.7	5.4	6.4	6.8	7.6	40.0
MONROE	0.0	3.9	4.8	5.5	6.5	6.9	7.7	40.5
MONGOMERY	0.0	3.4	4.2	4.9	5.7	6.2	7.0	39.0
MORGAN	0.0	3.3	4.1	4.8	5.5	6.1	6.8	39.0
MUHLENBERG	0.0	3.9	4.9	5.6	6.5	7.0	7.8	40.0
NELSON	0.0	3.7	4.5	5.2	6.2	6.5	7.3	39.0
NICHOLAS	0.0	3.4	4.1	4.9	5.6	6.1	6.9	38.5
OHIO	0.0	3.8	4.7	5.5	6.4	6.9	7.7	39.5
OLDHAM	0.0	3.6	4.4	5.0	6.0	6.3	7.2	38.5
OWEN	0.0	3.5	4.2	4.9	5.8	6.2	7.0	38.5
OWSLEY	0.0	3.5	4.3	5.0	5.8	6.4	7.1	40.0
PENDLETON	0.0	3.4	4.1	4.8	5.6	6.0	6.9	38.0
PERRY	0.0	3.4	4.2	4.9	5.7	6.4	7.0	40.0
PIKE	0.0	3.3	4.0	4.7	5.4	6.2	6.7	40.0
POWELL	0.0	3.5	4.2	5.0	5.7	6.2	7.0	39.5
PULASKI	0.0	3.7	4.5	5.2	6.1	6.6	7.4	40.0
ROBERTSON	0.0	3.4	4.1	4.8	5.6	6.0	6.8	38.5
ROCKCASTLE	0.0	3.6	4.4	5.1	6.0	6.5	7.2	40.0
ROWAN	0.0	3.3	4.0	4.8	5.5	6.0	6.8	39.0
RUSSELL	0.0	3.8	4.6	5.3	6.3	6.7	7.5	40.0
SCOTT	0.0	3.5	4.2	5.0	5.8	6.2	7.1	38.5
SHELBY	0.0	3.6	4.4	5.1	6.0	6.3	7.2	38.5
SIMPSON	0.0	3.9	4.9	5.6	6.5	7.0	7.8	40.5
SPENCER	0.0	3.6	4.4	5.1	6.1	6.4	7.2	39.0
TAYLOR	0.0	3.7	4.6	5.3	6.2	6.6	7.4	39.5
TODD	0.0	3.9	4.9	5.7	6.6	7.2	7.9	40.5
TRIGG	0.0	4.0	5.0	5.8	6.7	7.4	8.0	40.5
TRIMBLE	0.0	3.6	4.3	5.0	5.9	6.2	7.1	38.0
UNION	0.0	3.9	4.9	5.6	6.5	7.1	7.8	39.5
WARREN	0.0	3.9	4.8	5.5	6.5	6.9	7.7	40.0
WASHINGTON	0.0	3.6	4.4	5.2	6.1	6.5	7.3	39.0
WAYNE	0.0	3.7	4.6	5.3	6.3	6.8	7.5	40.5
WEBSTER	0.0	3.9	4.9	5.6	6.5	7.0	7.8	39.5
WHITLEY	0.0	3.7	4.6	5.2	6.1	6.7	7.4	41.0
WOLFE	0.0	3.4	4.1	4.9	5.6	6.2	6.9	39.5
WOODFORD	0.0	3.6	4.3	5.0	6.0	6.3	7.1	39.0

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)

4 DAY RAINFALL (INCHES)

	FREQUENCY (YEARS)					
COUNTY	2	5	10	25	50	100
ADAIR	4.4	5.6	6.3	7.4	8.0	8.7
ALLEN	4.6	5.8	6.6	7.9	8.5	9.0
ANDERSON	4.2	5.3	5.9	6.8	7.5	8.3
BALLARD	4.9	6.2	7.2	8.5	9.4	10.1
BARREN	4.5	5.7	6.5	7.7	8.3	8.9
BATH	4.0	4.9	5.6	6.5	7.2	8.0
BELL	4.1	5.3	6.0	7.0	7.9	8.5
BOONE	4.0	5.0	5.5	6.5	7.1	7.9
BOURBON	4.1	5.0	5.7	6.6	7.3	8.1
BOYD	3.8	4.7	5.4	6.1	6.8	7.5
BOYLE	4.2	6.3	6.0	6.9	7.7	8.4
BRACKEN	4.0	4.9	5.5	6.4	7.1	7.9
BREATHITT	4.0	4.9	5.7	6.6	7.4	8.0
BRECKINRIDGE	4.4	5.6	6.3	7.3	7.9	8.8
BULLITT	4.3	5.4	6.0	6.9	7.7	8.5
BUTLER	4.6	5.7	6.6	7.8	8.3	9.0
CALDWELL	4.7	5.9	6.9	8.2	8.9	9.5
CALLOWAY	4.1	5.1	5.9	6.8	7.6	8.2
CAMPBELL	4.0	4.9	5.5	6.4	7.0	7.9
CARLISLE	5.0	6.2	7.2	8.6	9.6	10.2
CARROLL	4.1	5.1	5.7	6.6	7.2	8.1
CARTER	3.9	4.7	5.4	6.2	6.9	7.6
CASEY	4.3	5.4	6.1	7.0	7.8	8.6
CHRISTIAN	4.7	5.9	6.9	8.2	8.9	9.5
CLARK	4.1	5.1	5.8	6.6	7.4	8.1
CLAY	4.0	5.1	5.9	6.9	7.7	8.2
CLINTON	4.5	5.7	6.4	7.6	8.2	8.8
CRITTENDEN	4.7	5.9	6.9	8.3	8.9	9.6
CUMBERLAND	4.5	5.7	6.4	7.6	8.2	8.9
DAVIESS	4.5	5.7	6.5	7.7	8.2	8.9
EDMONSON	4.5	5.7	6.5	7.6	8.2	8.9
ELLIOTT	3.9	4.8	5.5	6.3	7.0	7.7
ESTILL	4.1	5.1	5.8	6.7	7.5	8.2
FAYETTE	4.1	5.1	5.8	6.7	7.4	8.2
FLEMING	4.0	4.9	5.5	6.4	7.1	7.8
FLOYD	3.9	4.8	5.6	6.5	7.1	7.7
FRNAKLIN	4.2	5.2	5.8	6.7	7.4	8.2
FULTON	5.1	6.3	74	8.8	9.7	10.4
GALLATIN	4.1	5.0	5.6	6.5	7.2	8.0
GARRARD	4.2	5.2	6.0	6.8	7.6	8.3

4 DAY RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	2	5	10	25	50	100
GRANT	4.1	5.0	5.6	6.5	7.2	8.0
GRAVES	5.0	6.2	7.2	8.6	9.4	10.1
GRAYSON	4.5	5.6	6.4	7.5	8.0	8.8
GREEN	4.4	5.6	6.3	7.3	7.9	8.7
GREENUP	3.8	4.7	5.3	6.1	6.8	7.5
HANCOCK	4.5	5.6	6.3	7.4	7.9	8.8
HARDIN	4.4	5.5	6.2	7.2	7.8	8.7
HARLAN	4.0	5.0	5.9	6.8	7.7	8.2
HARRISON	4.1	5.0	5.7	6.5	7.2	8.0
HART	4.4	5.6	6.4	7.4	8.0	8.8
HENDERSON	4.6	5.8	6.6	7.8	8.5	9.0
HENRY	4.2	5.2	5.8	6.7	7.3	8.2
HICKMAN	5.0	6.3	7.3	8.7	9.5	10.2
HOPKINS	4.7	5.8	6.7	8.0	8.7	9.3
JACKSON	4.1	5.1	5.9	6.8	7.6	8.3
JEFFERSON	4.3	5.3	6.0	6.9	7.6	8.4
JESSAMINE	4.2	5.2	5.9	6.8	7.5	8.3
JOHNSON	3.9	4.8	5.5	6.4	7.1	7.7
KENTON	4.0	4.9	5.5	6.4	7.0	7.9
KNOTT	3.9	4.9	5.7	6.6	7.3	7.9
KNOX	4.1	5.3	6.0	7.0	7.8	8.4
LARUE	4.4	5.5	6.2	7.2	7.8	8.7
LAUREL	4.1	5.3	6.0	7.0	7.8	8.4
LAWRENCE	3.9	4.7	5.4	6.3	6.9	7.6
LEE	4.0	5.0	5.8	6.7	7.5	8.1
LESLIE	4.0	5.0	5.8	6.8	7.6	8.2
LETCHER	3.9	4.9	5.7	6.7	7.4	7.9
LEWIS	3.9	4.8	5.4	6.2	7.0	7.7
LINCOLN	4.2	5.3	6.0	6.9	7.7	8.4
LIVINGSTON	4.8	6.0	7.0	8.3	9.1	9.8
LOGAN	4.7	5.8	6.7	8.1	8.6	9.2
LYON	4.8	6.0	7.0	8.3	9.1	9.7
MCCRACKEN	4.9	6.1	7.1	8.5	9.3	10.0
MCCREARY	4.3	5.5	6.3	7.4	8.1	8.7
MCLEAN	4.6	5.8	6.6	7.8	8.4	9.0
MADISON	4.1	5.2	5.9	6.8	7.5	8.2
MAGOFFIN	3.9	4.9	5.6	6.5	7.2	7.8
MARION	4.3	5.4	6.1	7.0	7.8	8.6
MARSHALL	4.9	6.1	7.1	8.4	9.2	9.9
MARTIN	3.9	4.8	5.5	6.4	7.0	7.6

4 DAY RAINFALL (INCHES)

	FREQUENCY (YEARS)					
COUNTY	2	5	10	25	50	100
MASON	4.0	4.8	5.5	6.3	7.0	7.8
MEADE	4.4	5.5	6.1	7.1	7.8	8.6
MENIFEE	4.0	4.9	5.7	6.4	7.3	8.0
MERCER	4.2	5.3	6.0	6.5	7.7	8.4
METCALFE	4.5	5.7	6.4	7.5	8.1	8.8
MONROE	4.5	5.7	6.5	7.8	8.4	8.9
MONTGOMERY	4.0	5.0	5.7	6.6	7.3	8.1
MORGAN	3.9	4.8	5.6	6.5	7.2	7.9
MUHLENBERG	4.6	5.8	6.7	8.0	8.5	9.1
NELSON	4.3	5.4	6.1	7.0	7.7	8.5
NICHOLAS	4.0	4.9	5.6	6.5	7.2	8.0
OHIO	4.5	5.7	6.5	7.7	8.2	8.9
OLDHAM	4.2	5.2	5.8	6.8	7.4	8.3
OWEN	4.1	5.1	5.7	6.6	7.3	8.1
OWSLEY	4.0	5.0	5.8	6.8	7.5	8.2
PENDLETON	4.0	4.9	5.6	6.4	7.1	7.9
PERRY	4.0	5.0	5.8	6.7	7.5	8.0
PIKE	3.9	4.8	5.6	6.5	7.0	7.7
POWELL	4.0	5.0	5.8	6.6	7.4	8.1
PULASKI	4.3	5.4	6.1	7.1	7.9	8.6
ROBERTSON	4.0	4.9	5.5	6.4	7.1	7.9
ROCKCASTLE	4.2	5.3	6.0	6.9	7.7	8.4
ROWAN	3.9	4.8	5.5	6.4	7.1	7.8
RUSSELL	4.4	5.6	6.3	7.4	8.0	8.7
SCOTT	4.1	5.1	5.8	6.6	7.3	8.2
SHELBY	4.2	5.2	5.9	6.8	7.5	8.3
SIMPSON	4.6	5.8	6.7	8.0	8.6	9.2
SPENCER	4.3	5.3	6.0	6.9	7.6	8.4
TAYLOR	4.4	5.5	6.2	7.1	7.8	8.6
TODD	4.7	5.9	6.8	8.1	8.8	9.4
TRIGG	4.8	6.0	7.0	8.3	9.1	9.7
TRIMBLE	4.2	5.2	5.8	6.7	7.3	8.2
UNION	4.6	5.9	6.7	8.0	8.7	9.3
WARREN	4.6	5.8	6.6	7.8	8.4	9.0
WASHINGTON	4.3	5.4	6.0	6.9	7.7	8.5
WAYNE	4.4	5.6	6.3	7.4	8.1	8.7
WEBSTER	4.6	5.8	6.7	8.0	8.6	9.2
WHITLEY	4.2	5.4	6.1	7.4	8.0	8.6
WOLFE	4.0	4.9	5.7	6.6	7.3	8.0
WOODFORD	4.2	5.2	5.9	6.7	7.5	8.3

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
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7 DAY RAINFALL (INCHES)

	FREQUENCY (YEARS)					
COUNTY	2	5	10	25	50	100
ADAIR	5.1	6.4	7.2	8.5	9.4	10.3
ALLEN	5.3	6.7	7.6	8.8	9.8	10.7
ANDERSON	4.9	6.1	6.8	8.0	8.8	9.6
BALLARD	5.8	7.2	8.2	9.6	10.7	11.8
BARREN	5.2	6.6	7.4	8.7	9.6	10.5
BATH	4.5	5.7	6.5	7.6	8.4	9.3
BELL	4.8	6.2	6.9	8.2	9.2	10.1
BOONE	4.6	5.7	6.4	7.3	8.0	8.9
BOURBON	4.6	5.8	6.5	7.7	8.5	9.3
BOYD	4.2	5.4	6.1	7.3	7.8	8.9
BOYLE	4.9	6.2	6.9	8.1	9.0	9.8
BRACKEN	4.5	5.6	6.4	7.4	8.1	9.0
BREATHITT	4.6	5.8	6.6	7.8	8.5	9.4
BRECKINRIDGE	5.2	6.4	7.2	8.4	9.3	10.0
BULLITT	5.0	6.2	6.9	8.1	9.0	9.7
BUTLER	5.3	6.7	7.5	8.7	9.6	10.4
CALDWELL	5.5	6.9	7.9	9.1	10.1	11.0
CALLOWAY	5.7	7.2	8.2	9.5	10.6	11.5
CAMPBELL	4.5	5.6	6.4	7.4	8.0	8.9
CARLISLE	5.8	7.3	8.3	9.7	10.7	11.8
CARROLL	4.7	5.8	6.6	7.7	8.4	9.1
CARTER	4.3	5.5	6.2	7.3	7.9	8.9
CASEY	5.0	6.3	7.0	8.3	9.2	10.0
CHRISTIAN	5.5	6.9	7.9	9.1	10.1	10.9
CLARK	4.7	5.9	6.6	7.8	8.6	9.5
CLAY	4.8	6.0	6.8	8.0	8.9	9.8
CLINTON	5.2	6.5	7.3	8.6	9.6	10.7
CRITTENDEN	5.5	6.9	7.9	9.1	10.0	11.1
CUMBERLAND	5.2	6.5	7.4	8.6	9.6	10.6
DAVIESS	5.3	6.6	7.4	8.6	9.6	10.3
EDMONSON	5.2	6.6	7.4	8.6	9.6	10.3
ELLIOTT	4.4	5.6	6.3	7.5	8.1	9.1
ESTILL	4.7	5.9	6.7	7.9	8.7	9.6
FAYETTE	4.7	5.9	6.7	7.9	8.7	9.5
FLEMING	4.5	5.7	6.4	7.5	8.2	9.1
FLOYD	4.4	5.6	6.5	7.6	8.1	9.0
FRANKLIN	4.8	6.0	6.7	7.9	8.6	9.4
FULTON	5.9	7.4	8.5	9.9	11.0	12.0
GALLATIN	4.7	5.8	6.5	7.6	8.2	9.1
GARRARD	4.9	6.4	6.8	8.0	9.0	9.8

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
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7 DAY RAINFALL (INCHES)

	FREQUENCY (YEARS)					
COUNTY	2	5	10	25	50	100
GRANT	4.6	5.8	6.5	7.6	8.3	9.1
GRAVES	5.8	7.3	8.3	9.6	10.7	11.7
GRAYSON	5.2	6.5	7.3	8.5	9.4	10.2
GREEN	5.1	6.4	7.2	8.4	9.4	10.2
GREENUP	4.3	5.4	6.1	7.2	7.8	8.8
HANCOCK	5.2	6.5	7.3	8.4	9.3	10.1
HARDIN	5.1	6.4	7.1	8.3	9.2	9.8
HARLAN	4.7	5.9	6.8	8.0	8.8	9.6
HARRISON	4.6	5.8	6.5	7.6	8.3	9.2
HART	5.2	6.5	7.3	8.5	9.5	10.2
HENDERSON	5.3	6.7	7.5	8.7	9.6	10.6
HENRY	4.8	5.9	6.7	7.8	8.5	9.3
HICKMAN	5.8	7.3	8.4	9.8	10.8	11.9
HOPKINS	5.4	6.8	7.7	8.9	9.9	10.8
JACKSON	4.8	6.0	6.8	8.0	8.9	9.8
JEFFERSON	5.0	6.1	6.8	8.0	8.8	9.6
JESSAMINE	4.8	6.0	6.7	8.0	8.8	9.6
JOHNSON	4.4	5.6	6.4	7.5	8.1	9.0
KENTON	4.6	5.7	6.4	7.4	8.0	8.9
KNOTT	4.5	5.7	6.6	7.7	8.4	9.2
KNOX	7.8	6.1	6.9	8.2	9.1	10.0
LARUE	5.1	6.4	7.1	8.3	9.3	10.0
LAUREL	4.9	6.2	6.9	8.2	9.1	10.0
LAWRENCE	4.3	5.5	6.3	7.4	7.9	8.9
LEE	4.7	5.9	6.7	7.9	8.6	9.6
LESLIE	4.7	5.9	6.8	7.9	8.7	9.6
LETCHER	4.6	5.7	6.6	7.8	8.4	9.1
LEWIS	4.4	5.5	6.3	7.3	8.0	8.9
LINCOLN	4.9	6.2	6.9	8.1	9.0	9.9
LIVINGSTON	5.6	7.0	8.0	9.3	10.3	11.3
LOGAN	5.4	6.8	7.8	8.9	9.9	10.7
LYON	5.6	7.0	8.0	9.2	10.6	11.2
MCCRACKEN	5.7	7.2	8.2	9.5	10.5	11.6
MCCREARY	5.0	6.4	7.1	8.4	9.4	10.5
MCLEAN	5.3	6.7	7.5	8.7	9.7	10.5
MADISON	4.8	6.0	6.7	8.0	8.8	9.7
MAGOFFIN	4.5	5.7	6.5	7.6	8.2	9.2
MARION	5.0	6.3	7.0	8.2	9.2	9.9
MARSHALL	5.7	7.1	8.1	9.4	10.5	11.4
MARTIN	4.4	5.5	6.3	7.4	7.9	8.8

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7 DAY RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	2	5	10	25	50	100
MASON	4.5	5.6	6.3	7.4	8.0	9.0
MEADE	5.1	6.3	7.0	8.2	9.1	9.8
MENIFEE	4.5	5.8	6.5	7.7	8.4	9.3
MERCER	4.9	6.1	6.8	8.1	8.9	9.7
METCALFE	5.2	6.5	7.3	8.6	9.6	10.5
MONROE	5.3	6.6	7.5	8.7	9.7	10.7
MONTGOMERY	4.6	5.8	6.5	7.7	8.5	9.4
MORGAN	4.5	5.7	6.4	7.6	8.3	9.2
MUHLENBERG	5.4	6.8	7.7	8.8	9.8	10.6
NELSON	5.0	6.2	6.9	8.2	9.1	9.8
NICHOLAS	4.6	5.7	6.5	7.6	8.3	9.2
OHIO	5.3	6.6	7.5	8.7	9.6	10.3
OLDHAM	4.9	6.0	6.8	7.9	8.6	9.4
OWEN	4.7	5.8	6.6	7.7	8.4	9.2
OWSLEY	4.7	5.9	6.7	7.9	8.8	9.6
PENDLETON	4.6	5.7	6.4	7.5	8.2	9.0
PERRY	4.6	5.8	6.6	7.9	8.5	9.4
PIKE	4.5	5.5	6.4	7.5	8.0	8.9
POWELL	4.6	5.9	6.6	7.8	8.6	9.5
PULASKI	5.0	6.3	7.0	8.3	9.3	10.1
ROBERTSON	4.5	5.7	6.4	7.5	8.2	9.0
ROCKCASTLE	4.9	6.1	6.8	8.1	9.0	9.9
ROWAN	4.4	5.6	6.4	7.5	8.2	9.1
RUSSELL	5.1	6.4	7.2	8.5	9.4	10.3
SCOTT	4.7	5.9	6.6	7.8	8.5	9.3
SHELBY	4.9	6.0	6.8	7.9	8.7	9.5
SIMPSON	5.4	6.8	7.7	8.9	9.9	10.8
SPENCER	4.9	6.1	6.8	8.0	8.9	9.7
TAYLOR	5.1	6.3	7.0	8.3	9.3	10.0
TODD	5.5	6.9	7.8	9.0	10.0	10.8
TRIGG	5.6	7.1	8.0	9.3	10.3	11.2
TRIMBLE	4.8	5.9	6.7	7.8	8.5	9.3
UNION	5.5	6.8	7.7	8.9	9.9	10.9
WARREN	5.3	6.7	7.5	8.8	9.7	10.5
WASHINGTON	5.0	6.2	6.9	8.1	9.0	9.8
WAYNE	5.1	6.4	7.2	8.5	9.5	10.5
WEBSTER	5.4	6.8	7.7	8.9	9.9	10.8
WHITLEY	5.0	6.3	7.0	8.3	9.3	10.3
WOLFE	4.6	5.8	6.5	7.8	8.5	9.4
WOODFORD	4.8	6.0	6.7	7.9	8.7	9.5

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DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)

10 DAY RAINFALL (INCHES)

	FREQUENCY (YEARS)					
COUNTY	2	5	10	25	50	100
ADAIR	5.7	7.1	8.1	9.5	10.5	11.3
ALLEN	5.9	7.5	8.5	9.7	10.9	11.8
ANDERSON	5.5	6.7	7.6	8.9	9.8	10.6
BALLARD	6.3	7.9	9.3	10.3	11.9	13.2
BARREN	5.8	7.3	8.4	9.6	10.7	11.5
BATH	5.2	6.4	7.3	8.4	9.3	10.5
BELL	5.5	6.9	7.7	9.2	10.0	11.0
BOONE	5.2	6.3	7.2	8.3	9.0	9.9
BOURBON	5.3	6.5	7.4	8.6	9.4	10.3
BOYD	4.8	6.1	6.9	8.1	8.8	9.8
BOYLE	5.5	6.8	7.7	9.1	10.1	10.8
BRACKEN	5.1	6.3	7.1	8.3	9.0	9.9
BREATHITT	5.2	6.5	7.3	8.7	9.5	10.4
BRECKINRIDGE	5.7	7.0	8.2	9.3	10.3	11.2
BULLITT	5.5	6.9	7.8	9.1	10.1	10.9
BUTLER	5.8	7.4	8.5	9.6	10.7	11.6
CALDWELL	6.0	7.6	8.9	9.9	11.2	12.0
CALLOWAY	6.3	7.9	9.3	10.2	11.7	12.8
CAMPBWLL	5.1	6.3	7.1	8.3	8.9	9.9
CARLISLE	6.3	8.0	9.4	10.3	11.9	13.3
CARROLL	5.3	6.5	7.4	8.6	9.4	10.2
CARTER	5.0	6.2	7.0	8.3	9.0	9.9
CASEY	5.6	7.0	7.9	9.3	10.3	11.0
CHRISTIAN	6.0	7.7	8.9	9.9	11.2	12.0
CLARK	5.3	6.6	7.5	8.7	9.6	10.4
CLAY	5.4	6.7	7.5	9.0	9.8	10.7
CLINTON	5.8	7.3	8.2	9.4	10.8	11.5
CRITTENDEN	6.0	7.6	9.0	9.9	11.3	12.1
CUMBERLAND	5.8	7.3	8.2	9.6	10.8	11.5
DAVIESS	5.8	7.3	8.4	9.5	10.6	11.5
EDMONSON	5.8	7.3	8.4	9.6	10.6	11.4
ELLIOTT	5.0	6.3	7.1	8.3	9.1	10.0
ESTILL	5.4	6.6	7.5	8.8	9.7	10.6
FAYETTE	5.4	6.6	7.5	8.8	9.6	10.5
FLEMING	5.1	6.3	7.2	8.3	9.1	10.0
FLOYD	4.9	6.2	7.0	8.4	9.1	10.0
FRNAKLIN	5.4	6.6	7.5	8.8	9.6	10.4
FULTON	6.5	8.1	9.6	10.5	12.2	13.6
GALLATIN	5.2	6.4	7.3	8.4	9.2	10.2
GARRARD	5.5	6.7	7.6	9.0	9.9	10.8

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)

10 DAY RAINFALL (INCHES)

	FREQUENCY (YEARS)					
COUNTY	2	5	10	25	50	100
GRANT	5.2	6.4	7.3	8.4	9.2	10.0
GRAVES	6.3	7.9	9.3	10.3	11.9	13.0
GRAYSON	5.7	7.2	8.3	9.5	10.5	11.3
GREEN	5.7	7.1	8.1	9.4	10.4	11.2
GREENUP	4.9	6.1	6.9	8.1	8.8	9.8
HANCOCK	5.7	7.2	8.3	9.4	10.3	11.3
HARDIN	5.6	7.0	8.1	9.3	10.2	11.1
HARLAN	5.2	6.7	7.3	8.9	9.6	10.7
HARRISON	5.3	6.4	7.3	8.5	9.3	10.1
HART	5.7	7.2	8.2	9.5	10.5	11.3
HENDERSON	5.8	7.4	8.6	9.6	10.8	11.7
HENRY	5.4	6.6	7.5	8.7	9.5	10.3
HICKMAN	6.4	8.0	9.5	10.4	12.0	13.4
HOPKINS	5.9	7.5	8.8	9.8	11.0	11.8
JACKSON	5.4	6.7	7.6	9.0	9.8	10.7
JEFFERSON	5.5	6.8	7.7	9.0	9.9	10.7
JESSAMINE	5.4	6.7	7.6	8.9	9.8	10.6
JOHNSON	5.0	6.2	7.0	8.4	9.1	10.0
KENTON	5.1	6.3	7.2	8.3	8.9	9.9
KNOTT	5.0	6.4	7.1	8.6	9.3	10.3
KNOX	5.5	6.9	7.7	9.2	10.0	11.0
LARUE	5.6	7.0	8.0	9.3	10.3	11.1
LAUREL	5.5	6.8	7.7	9.3	10.1	11.0
LAWRENCE	4.9	6.2	6.9	8.3	8.9	9.9
LEE	5.3	6.6	7.4	8.8	9.5	10.5
LESLIE	5.3	6.7	7.4	8.9	9.7	10.7
LETCHER	4.9	6.4	7.1	8.7	9.3	10.1
LEWIS	5.0	6.2	7.1	8.3	9.0	9.8
LINCOLN	5.5	6.8	7.7	9.2	10.1	10.9
LIVINGSTON	6.1	7.7	9.1	10.0	11.5	12.5
LOGAN	6.0	7.6	8.7	9.8	11.0	11.8
LYON	6.1	7.7	9.1	10.0	11.4	12.4
MCCRACKEN	6.2	7.9	9.2	10.2	11.8	12.9
MCCREARY	5.7	7.1	8.0	9.5	10.5	11.3
MCLEAN	5.9	7.4	8.6	9.7	10.8	11.6
MADISON	5.4	6.6	7.6	8.9	9.8	10.7
MAGOFFIN	5.1	6.3	7.1	8.5	9.2	10.2
MARION	5.6	6.9	7.8	9.2	10.2	11.0
MARSHALL	6.2	7.8	9.2	10.1	11.7	12.7
MARTIN	4.8	6.1	6.8	8.3	9.0	9.8

DIVISION OF WATER RESOURCES
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10 DAY RAINFALL (INCHES)

FREQUENCY (YEARS)

COUNTY	2	5	10	25	50	100
MASON	5.1	6.3	7.1	8.3	9.0	9.9
MEADE	5.6	7.0	8.0	9.2	10.1	11.0
MENIFEE	5.2	6.4	7.3	8.5	9.5	10.3
MERCER	5.5	6.8	7.7	9.0	9.9	10.7
METCALFE	5.8	7.3	8.2	9.6	10.7	11.5
MONROE	5.9	7.4	8.4	9.7	10.9	11.7
MONTGOMERY	5.3	6.5	7.4	8.4	9.4	10.3
MORGAN	5.1	6.4	7.2	8.5	9.3	10.2
MUHLENBERG	5.9	7.5	8.6	9.8	10.9	11.7
NELSON	5.6	7.0	7.8	9.2	10.1	10.9
NICHOLAS	5.2	6.4	7.3	8.4	9.2	10.1
OHIO	5.8	7.3	8.4	9.6	10.6	11.5
OLDHAM	5.4	6.7	7.6	8.8	9.6	10.4
OWEN	5.3	6.5	7.4	8.6	9.4	10.2
OWSLEY	5.4	6.6	7.4	8.8	9.7	10.6
PENDLETON	5.2	6.3	7.2	8.4	9.1	10.0
PERRY	5.2	6.5	7.2	8.8	9.5	10.4
PIKE	4.9	6.1	6.8	8.4	8.9	9.9
POWELL	5.3	6.5	7.4	8.6	9.6	10.5
PULASKI	5.6	6.9	7.8	9.3	10.3	11.1
ROBERTSON	5.2	6.4	7.2	8.4	9.1	10.0
ROCKCASTLE	5.5	6.8	7.7	9.1	10.0	10.9
ROWAN	5.1	6.3	7.2	8.4	9.2	10.1
RUSSELL	5.7	7.1	8.0	9.5	10.6	11.3
SCOTT	5.3	6.5	7.5	8.7	9.5	10.3
SHELBY	5.4	6.7	7.6	8.9	9.7	10.4
SIMPSON	6.0	7.5	8.7	9.8	11.0	11.8
SPENCER	5.5	6.8	7.7	9.0	9.9	10.6
TAYLOR	5.6	7.0	8.0	9.3	10.3	11.1
TODD	6.0	7.3	8.8	9.9	11.1	11.9
TRIGG	6.1	7.8	9.0	10.0	11.5	12.3
TRIMBLE	5.3	6.6	7.5	8.7	9.5	10.2
UNION	5.9	7.5	8.8	9.5	11.0	11.9
WARREN	5.9	7.4	8.5	9.7	10.8	11.7
WASHINGTON	5.5	6.8	7.7	9.1	10.0	10.8
WAYNE	5.8	7.2	8.0	9.5	10.7	11.4
WEBSTER	5.9	7.5	8.7	9.7	11.0	11.8
WHITLEY	5.7	7.0	7.9	9.3	10.3	11.2
WOLFE	5.2	6.5	7.3	8.6	9.5	10.4
WOODFORD	5.4	6.6	7.6	8.9	9.7	10.5

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)
ONE DAY AND TEN DAY DIRECT DISCHARGES (INCHES)
QUICK RETUN FLOWS (CSM)

COUNTY	ONE DAY 25	ONE DAY 50	ONE DAY 100	TEN DAY 25	TEN DAY 50	TEN DAY 100	QUICK RETURN FLOWS (CSM)
	FREQUENCY (YEARS)						
ADAIR	4.0	4.3	4.7	7.9	8.6	9.3	7.5
ALLEN	4.1	4.5	4.9	8.2	8.9	9.7	7.6
ANDERSON	3.9	4.2	4.6	7.8	8.5	9.2	7.0
BALLARD	4.1	4.5	4.9	8.2	8.9	9.7	6.3
BARREN	4.1	4.4	4.8	8.2	8.8	9.6	7.6
BATH	3.7	4.0	4.3	7.3	7.9	8.6	6.4
BELL	3.7	4.0	4.3	7.3	7.9	8.6	7.6
BOONE	3.7	4.0	4.3	7.3	7.9	8.6	6.2
BOURBON	3.7	4.0	4.4	7.5	8.1	8.8	6.7
BOYD	3.2	3.5	3.8	6.4	6.9	7.5	4.9
BOYLE	3.9	4.2	4.6	7.8	8.5	9.2	7.2
BRACKEN	3.6	3.9	4.3	7.2	7.8	8.5	6.3
BREATHITT	3.6	3.9	4.2	7.1	7.7	8.4	6.8
BRECKINRIDGE	4.2	4.5	4.9	8.3	9.0	9.8	6.9
BULLITT	4.0	4.4	4.8	8.1	8.7	9.5	7.0
BUTLER	4.2	4.6	5.0	8.4	9.1	9.9	7.2
CALDWELL	4.3	4.6	5.0	8.5	9.2	10.0	6.7
CALLOWAY	4.3	4.6	5.0	8.5	9.2	10.0	6.8
CAMPBELL	3.6	3.9	4.2	7.1	7.7	8.4	6.2
CARLISLE	4.1	4.4	4.2	8.2	8.8	9.6	6.4
CARROLL	3.9	4.2	4.6	7.8	8.5	9.2	6.4
CARTER	3.4	3.7	4.0	6.8	7.4	8.0	5.2
CASEY	3.9	4.2	4.6	7.8	8.5	9.2	7.4
CHRISTIAN	4.3	4.6	5.0	8.5	9.2	10.0	7.0
CLARK	3.7	4.0	4.4	7.5	8.1	8.8	6.8
CLAY	3.7	4.0	4.6	7.3	7.9	8.6	7.4
CLINTON	4.0	4.3	4.7	7.9	8.6	9.3	7.7
CRITTENDEN	4.3	4.6	5.0	8.5	9.2	10.0	6.5
CUMBERLAND	4.0	4.3	4.7	8.0	8.6	9.4	7.6
DAVIESS	4.3	4.6	5.0	8.5	9.2	10.0	6.7
EDMONSON	4.1	4.5	4.9	8.2	8.9	9.7	7.3
ELLIOTT	3.4	6.7	4.1	6.9	7.5	8.1	5.5
ESTILL	3.7	4.0	4.4	7.4	8.0	8.7	7.0
FAYETTE	3.8	4.1	4.5	7.7	8.3	9.0	6.9
FLEMING	3.6	3.9	4.2	7.1	7.7	8.4	6.3
FLOYD	3.4	3.6	4.0	6.7	7.3	7.9	6.0
FRANKLIN	3.9	4.2	4.6	7.7	8.4	9.1	6.8
FULTON	3.9	4.2	4.6	7.8	8.5	9.2	6.4
GALLATIN	3.8	4.1	4.5	7.7	8.3	9.0	6.4
GARRARD	3.9	4.2	4.6	7.7	8.4	9.1	7.2

DIVISION OF WATER RESOURCES
DEPARTMENT FOR NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION
ENGINEERING MEMORANDUM NO.2 (4-30-71), REVISED (6-1-79)
ONE DAY AND TEN DAY DIRECT DISCHARGES (INCHES)
QUICK RETUN FLOWS (CSM)

	ONE DAY			TEN DAY			QUICK RETURN FLOWS (CSM)
	FREQUENCY (YEARS)						
COUNTY	25	50	100	25	50	100	
GRANT	3.8	4.1	4.5	7.6	8.2	8.9	6.4
GRAVES	4.3	4.6	5.0	8.5	9.2	10.0	6.6
GRAYSON	4.2	4.5	4.9	8.3	9.0	9.8	7.8
GREEN	4.0	4.3	4.7	8.0	8.6	9.4	7.4
GREENUP	3.3	3.5	3.9	6.5	7.1	7.7	4.9
HANCOCK	4.2	4.6	5.0	8.4	9.1	9.9	6.7
HARDIN	4.1	4.4	4.8	8.2	8.8	9.6	7.1
HARLAN	3.5	3.8	4.2	7.1	7.6	8.6	7.4
HARRISON	3.7	4.0	4.4	7.5	8.1	8.8	6.6
HART	4.1	4.4	4.8	8.2	8.8	9.6	7.3
HENDERSON	4.3	4.6	5.0	8.5	9.2	10.0	6.4
HENRY	3.9	4.2	4.6	7.8	8.5	9.2	6.6
HICKMAN	4.0	4.4	4.8	8.1	8.7	9.5	6.5
HOPKINS	4.3	4.6	5.0	8.5	9.2	10.0	6.8
JACKSON	3.7	4.0	4.4	7.5	8.1	8.8	7.3
JEFFERSON	4.0	4.3	4.7	8.0	8.6	9.4	6.7
JESSAMINE	3.9	4.2	4.6	7.7	8.4	9.1	7.0
JOHNSON	3.4	3.6	4.0	6.7	7.3	7.9	5.5
KENTON	3.6	3.9	4.3	7.2	7.8	8.5	6.2
KNOTT	3.4	6.7	4.0	6.8	7.4	8.0	6.7
KNOX	3.7	4.0	4.4	7.4	8.0	8.7	7.6
LARUE	4.0	4.4	4.8	8.1	8.7	9.5	7.2
LAUREL	3.8	4.1	4.5	7.6	8.2	8.9	7.5
LAWRENCE	3.3	3.5	3.9	6.5	7.4	7.7	5.0
LEE	3.7	4.0	4.3	7.3	7.9	8.6	7.0
LESLIE	3.6	3.9	4.2	7.1	7.7	8.4	7.3
LETCHER	3.4	3.7	4.0	6.8	7.4	8.0	7.0
LEWIS	3.5	3.8	4.1	7.0	7.5	8.2	5.7
LINCOLN	3.9	4.2	4.6	7.7	8.4	9.1	7.3
LIVINGSTON	4.3	4.6	5.0	8.5	9.2	10.0	6.5
LOGAN	4.3	4.6	5.0	8.5	9.2	10.0	7.3
LYON	4.3	4.6	5.0	8.5	9.2	10.0	6.7
MCCRACKEN	4.3	4.6	5.0	8.5	9.2	10.0	6.4
MCCREARY	3.9	4.2	4.6	7.7	8.4	9.1	7.7
MCLEAN	4.3	4.6	5.0	8.5	9.2	10.0	6.7
MADISON	3.8	4.1	4.5	7.7	8.3	9.0	7.1
MAGOFFIN	3.4	3.7	4.1	6.9	7.5	8.1	6.0
MARION	4.0	4.3	4.7	7.9	8.6	9.3	7.3
MARSHALL	4.3	4.6	5.0	8.5	9.2	10.0	6.7
MARTIN	3.3	3.6	3.9	6.6	7.2	7.8	5.0

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QUICK RETUN FLOWS (CSM)

	ONE DAY			TEN DAY			QUICK RETURN FLOWS (CSM)
	FREQUENCY (YEARS)						
COUNTY	25	50	100	25	50	100	
MASON	3.6	3.9	4.2	7.1	7.7	8.4	6.2
MEADE	4.1	4.5	4.9	8.2	8.9	9.7	6.8
MENIFEE	3.6	3.9	4.3	7.2	7.8	8.5	6.5
MERCER	3.9	4.2	4.6	7.8	8.5	9.2	7.2
METCALFE	4.1	4.4	4.8	8.2	8.8	9.6	7.5
MONROE	4.1	4.4	4.8	8.2	8.8	9.6	7.7
MONTOMERY	3.7	4.0	4.4	7.4	8.0	8.7	6.7
MORGAN	3.5	3.8	4.2	7.1	7.6	8.3	6.0
MUHLENBERG	4.3	4.6	5.0	8.5	9.2	10.0	7.0
NELSON	4.0	4.3	4.7	8.0	8.6	9.4	7.0
NICHOLAS	3.7	4.0	4.3	7.3	7.9	8.6	6.5
OHIO	4.2	4.6	5.0	8.4	9.1	9.9	7.0
OLDHAM	4.0	4.3	4.7	7.9	8.6	9.3	6.7
OWEN	3.9	4.2	4.6	7.7	8.4	9.1	6.5
OWSLEY	3.7	4.0	4.3	7.3	7.9	8.6	7.2
PENDLETON	3.7	4.0	4.4	7.4	8.0	8.7	6.4
PERRY	3.5	3.8	4.2	7.1	7.6	8.3	7.0
PIKE	3.3	3.5	3.9	6.5	7.1	7.7	6.0
POWELL	3.7	4.0	4.3	7.3	7.9	8.6	6.8
PULASKI	3.9	4.2	4.6	7.7	8.4	9.1	7.5
ROBERTSON	3.6	3.9	4.3	7.2	7.8	8.5	6.4
ROCKCASTLE	3.8	4.1	4.5	7.7	8.3	9.0	7.3
ROWAN	3.5	3.8	4.2	7.1	7.6	8.3	6.0
RUSSELL	4.0	4.3	4.7	7.9	8.6	9.3	7.6
SCOTT	3.8	4.1	4.5	7.7	8.3	9.0	6.7
SHELBY	4.0	4.3	4.7	7.9	8.6	9.3	6.8
SIMPSON	4.2	4.6	5.0	8.4	9.4	9.9	7.5
SPENCER	4.0	4.3	4.7	7.9	8.6	9.3	6.9
TAYLOR	4.0	4.3	4.7	8.0	8.6	9.4	7.4
TODD	4.3	4.6	5.0	8.5	9.2	10.0	7.2
TRIGG	4.3	4.6	5.0	8.5	9.2	10.0	6.9
TRIMBLE	4.0	4.3	4.7	7.9	8.6	9.3	6.4
UNION	4.3	4.6	5.0	8.5	9.2	10.0	6.4
WARREN	4.2	4.5	4.9	8.3	9.0	9.8	7.5
WASHINGTON	4.0	4.3	4.7	7.9	8.6	9.3	7.2
WAYNE	3.9	4.2	4.6	7.8	8.5	9.2	7.7
WEBSTER	4.3	4.6	5.0	8.5	9.2	10.0	6.6
WHITLEY	3.8	4.1	4.5	7.6	8.2	8.9	7.7
WOLFE	3.6	3.9	4.3	7.2	7.8	8.5	6.6
WOODFORD	3.9	4.2	4.6	7.7	8.4	9.1	7.0

Reference 17

Winchester Municipal Utilities

KY0250473

DRINKING WATER QUALITY REPORT 2016

150 North Main Street
PO Box 4177
Winchester, KY 40392-4177

The Winchester Municipal Utilities (WMU), your drinking water provider, works around the clock to provide exceptional water, wastewater, and solid waste utility services to every consumer. This Drinking Water Quality Report provides you with information regarding your drinking water. For additional information, call WMU at 744-5434.

Este informe contiene informacion importante acerca de su agua potable. Haga que alguien lo traduzca para usted, o hable con alguien que lo entienda.

Website: www.wmutilities.com

BACKGROUND INFORMATION ABOUT WMU

The Winchester Municipal Utilities (WMU) is pleased to provide its Drinking Water Quality Report for 2016. The report is designed to inform you about the quality of your drinking water and is based on monitoring and test results for the year January 1 through December 31, 2015. Water treatment is a complex and highly regulated activity. WMU strives to continually improve the quality of its drinking water and of the many other utility services provided to you, our customer.

WMU's raw (untreated) water sources are the Kentucky River (Pool 10) and the Carroll E. Ecton Reservoir, which are surface water sources. The Kentucky River supplied 74% and the Carroll E. Ecton Reservoir supplied 26% of the water treated in 2015. WMU treated 1,641,510,000 gallons of water during 2015 from the Kentucky River and the Carroll E. Ecton Reservoir. The Kentucky River is most vulnerable to contamination from agricultural runoff, which may include pesticides, nutrients and silt from croplands, and substances resulting from the presence of animals on pasture lands. The Carroll E. Ecton Reservoir is most vulnerable to urban storm water runoff, which may include heavy metals from paved areas, nutrients, pesticides and organics (e.g., yard waste) from lawn care. Industrial and construction runoff in urban areas may include silts, synthetic chemicals and metals.

WMU's overall susceptibility to contamination shall be labeled as Moderate. Microbial contaminants, such as Total Coliform, Fecal Coliform, and E Coli are naturally present in the environment, and their presence is tested regularly. Inorganic contaminants, such as copper, fluoride, nitrates, and nitrites are also potential sources of contamination. WMU has a very stringent water sampling program and we take great pride in continuing to ensure our public has the purest drinking water at all hours of the day. All water quality standards are being met by the dedication of our staff and with the assistance of Microbac Laboratories. A complete source water assessment can be obtained or reviewed at WMU, 150 N. Main Street, Winchester, Kentucky.

The water treatment plant has a rated maximum treatment capacity of 6.0 million gallons per day (MGD). WMU operates its water treatment plant 24 hours per day, 365 days per year. The treatment process utilizes conventional flocculation, sedimentation, high-rate filtration, and disinfection.

WMU provides water service to a customer base of 11,670 direct customers and through water sold for resale, to 2,409 customers of the East Clark County Water District and 192 customers of the Kentucky American Water Company. In total, WMU serves 14,168 water customers in Clark County. Future growth, along with increasing regulatory requirements demands that WMU address the potable water supply to continue to provide high quality drinking water to you, our customer.

SUMMARY OF 2015 WATER QUALITY

WMU routinely monitors for contaminants in your drinking water according to Federal and State regulations. The following table provides the results of our monitoring averages for the period of January 1 through December 31, 2015. Important notes and explanatory definitions are provided at the end of the table.

	Allowable Levels	Highest Single Measurement	Lowest Monthly %	Violation	Likely Source of Contamination
Turbidity (NTU) *Representative samples of filtered water	No more than 1 NTU* Less than 0.3 NTU in 95% of monthly samples	0.24	100%	No	Soil runoff

Regulated Contaminant Test Results

Contaminant [code] (units)	MCL	MCLG	Report Level	Range of Detection	Date of Sample	Violation	Likely Source of Contamination
Radioactive Contaminants							
Beta photon emitters(pCi/L)	50	0	3.9	3.9 to 3.9	Jun 14	No	Decay of natural and man-made deposits
Alpha emitters [4000] (pCi/L)	15	0	2.6	2.6 to 2.6	Jun 14	No	Erosion of natural deposits
Combined radium (pCi/L)	5	0	1.53	1.53 to 1.53	Jun 14	No	Erosion of natural deposits
Inorganic Contaminants							
Barium [1010] (ppm)	2	2	0.017	0.017 to 0.017	Mar 15	No	Drilling wastes; metal refineries; erosion of natural deposits
Copper [1022] (ppm) sites exceeding action level 0	AL =1.3	1.3	0.14 (90th percentile)	0.011 to 0.28	Aug 13	No	Corrosion of household plumbing Systems
Lead [1030] (ppb) Sites exceeding action level = 0	AL =15	0	1.8 (90th percentile)	0 to 10	Aug 13	No	Corrosion of household plumbing systems
Fluoride [1025] (ppm)	4	4	0.9	.9 to .9	Mar 15	No	Water additive which promotes strong teeth
Nitrate [1040] (ppm)	10	10	0.24	0.24 to 0.24	Feb 15	No	Fertilizer runoff; leaching from septic tanks, sewage; erosion of natural deposits
Disinfectants/Disinfection Byproducts and Precursors							
Total Organic Carbon (ppm) (measured as ppm, but reported as a ratio)	TT*	N/A	1.57 (lowest average)	1.14 to 3.51 (monthly ratios)	2015	No	Naturally present in environment
Chlorine (ppm)	MRDL= 4	MRDLG = 4	1.20 (highest average)	0.20 to 2.1	2015	No	Water additive used to control microbes.
HAA (ppb) (Stage 2) [Haloacetic acids]	60	N/A	35 (High site average)	2 to 45 (range of individual sites)	2015	No	Byproduct of drinking water disinfection
TTHM (ppb) (Stage 2) [total trihalo-methanes]	80	N/A	48 (high site average)	6 to 83 (range of individua l sites)	2015	No	Byproduct of drinking water disinfection.

****TT for TOCs; % TOC removal achieved to the % TOC removal required. A minimum ratio 1.0 is required to meet the TT.**

Unregulated Contaminant Results (UCMR3)

		Avg	Range (ppb)	Date		
Vanadium		0.088	BDL to 0.35	Jan 15		
Strontium		112.500	BDL to 250	Jan 15		
Chromium-6		0.034	BDL to 0.068	Jan 15		
Total chromium		0.060	BDL to 0.24	Jan15		

EPA has not established drinking water standards for unregulated contaminants. There are no MCL's and therefore no violations if found.

BDL – Below Detection Limit

Public Notice of Availability of Data: In 2013, Winchester Municipal Utilities (PWS ID 0250473) completed unregulated contaminant monitoring as required by the Unregulated Contaminant Monitoring Rule 3 (UCMR3). In 2014, Winchester Municipal Utilities (PWS ID 0250473) completed three of four quarters of required monitoring. The last quarter of monitoring was completed in the first quarter of 2015 and those results will appear in the 2016 CCR. Unregulated contaminants are those for which EPA has not established drinking water standards. The purpose of the unregulated contaminant monitoring is to assist EPA in determining the occurrence of unregulated contaminants in drinking water and whether future regulation is warranted. The detected contaminants from 2015 monitoring are listed above under the Unregulated Contaminants section of this Water Quality Table. A list of all analytical results is available to the public by calling Michael H. Flynn, WMU General Manager at 859-744-5434 or emailing Mike@wmutilities.com.

DETECTED CONTAMINANTS

The data presented in this report are from the most recent testing done in accordance with administrative regulations in 401 KAR Chapter 8. As authorized and approved by EPA, the State has reduced monitoring requirements for certain contaminants to less often than once per year because the concentrations of these contaminants are not expected to vary significantly from year to year. Some of the data in this table, though representative, may be more than one year old. Unless otherwise noted, the report level is the highest level detected.

Unregulated Contaminant Results (UCMR3)

Our water system has sampled for a series of unregulated contaminants. Unregulated contaminants are those that don't yet have a drinking water standard set by EPA. The purpose of monitoring for these contaminants is to help EPA decide whether the contaminants should have a standard. As our customers, you have a right to know that this data is available. If you are interested in examining the results, please contact our office during normal business hours.

OTHER TESTS

WMU regularly tests your drinking water for 77 other primary standards, 16 secondary standards, and other standards for which results were found to be within acceptable levels. In order to make this report easier to read and understand, results of those tests are not reported here.

LEAD

If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. WMU is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking and cooking. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

REPORTING REQUIREMENTS

The United States Environmental Protection Agency (EPA) requires that every water system provide consumers with an annual consumer confidence or water quality report as a result of the Safe Drinking Water Act Amendments of 1996. The report is intended to provide consumers with information regarding the quality of their drinking water and to encourage actions by consumers to protect drinking water supplies. WMU is providing you with this report so that you might be better informed about the quality of your drinking water.

IMPORTANT DEFINITIONS

MCL - Maximum Contaminant Level
The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLG as feasible using the best available treatment technology.

MCLG - Maximum Contaminant Level Goal
The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.

MRDL - Maximum Residual Disinfectant Level
The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

MRDLG - Maximum Residual Disinfectant Level Goal
The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.

ND or N/A
Not detected; does not apply; not available

NTU - Nephelometric Turbidity Units
A measure of water turbidity. Turbidity is monitored because it is a good indicator of the effectiveness of the filtration system.

pCi/L - Picocuries per Liter
A unit of measure of radioactivity.

ppm - Parts per Million
A unit of measure; equal to milligrams per liter (mg/L).

ppb - Parts per Billion
A unit of measure; equal to micrograms per liter (mg/L).

Primary Standards
Mandatory standards established and enforced by EPA and the Kentucky Division of Water that relate to water quality health effects and for which monitoring is required.

TT - Treatment Technique
A required process intended to reduce the level of a contaminant in drinking water.

AL - Action Level
That concentration of a contaminant, which, if exceeded, triggers treatment or other requirements, which a water system must follow.

CRYPTOSPORIDIUM

WMU has voluntarily tested its source water supplies and it's finished (treated) water for the presence of *Cryptosporidium*. Cryptosporidium is a microbial parasite which is found in surface waters throughout the United States and has been found to be present in both the Kentucky River and the Carroll E. Ecton Reservoir. **Cryptosporidium has not been detected in WMU drinking water.** Although conventional treatment can remove cryptosporidium, commonly used sedimentation and filtration methods cannot guarantee 100% removal. Symptoms of Cryptosporidium infection include nausea, diarrhea, and abdominal c ramps. Most healthy individuals are able to overcome the infection within a few weeks. However, immuno-compromised people have more difficulty and are at greater risk of developing severe, life-threatening illness.

WHY ARE THERE CONTAMINANTS IN DRINKING WATER?

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects may be obtained by calling the Environmental Protection Agency's Safe Drinking Water Hotline at (800) 426-4791.

The sources of drinking water; (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material, and may pick up substances resulting from the presence of animals or from human activity.

Contaminants that may be present in source water before treatment include:

- *Microbial contaminants*, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock, and wildlife.
- *Inorganic contaminants*, such as salts and metals, which can be naturally-occurring or result from urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.
- *Pesticides and herbicides*, which may come from a variety of sources such as agriculture, storm water runoff, and residential uses.
- *Organic chemical contaminants*, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also, come from gas stations, urban storm water runoff, and septic systems.
- *Radioactive contaminants*, which can be naturally occurring or be the result of oil and gas production and mining activities.

In order to ensure that tap water is safe to drink, the EPA prescribes regulations which limit the amount of certain contaminants in water provided by public water systems. US FDA regulations establish limits for contaminants in bottled water that shall provide the same protection for public health. EPA has determined that drinking water is safe at these levels.

DO I NEED TO TAKE SPECIAL PRECAUTIONS?

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno- compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. EPA and the Centers for Disease Control and Prevention (CDC) guidelines on appropriate means to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants are available from the Safe Drinking Water Hotline at (800) 426-4791.

WATER SYSTEM IMPROVEMENTS

Previous decisions by the WMU and City Commissions have provided for construction of a new water treatment plant and associated infrastructure. Construction will include a new water treatment plant, raw water transmission improvements, and finished water transmission improvements. Final effective capacities will be determined by the Division of Water (DOW) with design of the new facilities. Raw and Finished Water Transmission Improvements were completed in January 2016. Kentucky River Pump Station upgrades are expected to be completed in April 2016. The transmission improvements included approximately 9 miles of 24-inch ductile iron pipe beginning at the Kentucky River Pumping Station extending along Boonesboro Road, interconnecting with the existing water treatment plant facilities and ending with connection at the Winchester Bypass.

The new Water Treatment Plant design is expected to begin April 2016 with initiation of construction planned for calendar year 2017 and completion calendar year 2019. Total costs associated with water system improvements are expected to be 35-40 million dollars.

CONSENT DECREE

The Consent Decree is the settlement agreement between the United States Environmental Agency (EPA), the Kentucky Energy and Environment Cabinet (EEC, formerly known as the Environmental and Public Protection Cabinet), City and WMU detailing actions to be taken by City and WMU for violations of the Clean Water Act , 33 U.S.C. § 1319. The basic tenants of the Consent Decree call for City and WMU to

- Eliminate existing and recurring sanitary sewer overflows (SSOs)
- Reduce the potential for future SSOs

Such is being achieved through a defined capital program and structured capacity, maintenance, operation, and management (CMOM) program.

During 2015 WMU spent $448,155.43 on Consent Decree capital projects. Since entry of the Consent Decree in April 2007 WMU has expended $70,496,438.77 for capital projects to address requirements of the Consent Decree and eliminate I/I.

Calendar year 2015 expenditures for CMOM related activities totaled $142,112.00. Total cost to-date for development and implementation of WMU's CMOM programs is $2,818,242.00.

CAPITAL PROJECTS

Projects under or scheduled for construction include:

New Water Treatment Plant (estimate)	$28,154,601
Raw Water Intake Improvements (bid)	$ 1,213,123
Hampton Manor Sewer Improvements	$ 1,400,000
Maple Street Sewer Replacement (bid)	$ 400,000

INFORMATION AND PUBLIC INPUT

If you have questions regarding the information provided in this report or about utility services provided by WMU, please contact WMU (859) 744-5434 or visit WMU's website at wmutilities.com. We want you to be informed about the drinking water quality and the utility services provided by WMU.

WMU operates as an enterprise fund of the city of Winchester. Regular public meetings of the WMU Commission are held on the first and third Thursdays of each month at 5:30 p.m. at the WMU administrative offices located at 150 North Main Street, Winchester. The regular meeting agenda for each meeting provides an opportunity for public comment regarding WMU services and operations. The WMU Commission is comprised of local community leaders who are WMU customers and who are very interested in your input. You are invited to avail yourself of this opportunity for public input.

Reference 18

Species Information

State Threatened, Endangered, and Special Concern Species observations for selected counties

Linked life history provided courtesy of NatureServe Explorer .

Records may include both recent and historical observations.

US Status Definitions Kentucky Status Definitions

List State Threatened, Endangered, and Special Concern Species observations in 1 selected county.

Selected county is: Madison.

Scientific Name and Life History	Common Name and Pictures	Class	County	US Status	KY Status	WAP	Reference
Accipiter striatus	Sharp-shinned Hawk	Aves	Madison	N	S	Yes	Reference
Actitis macularius	Spotted Sandpiper	Aves	Madison	N	E	Yes	Reference
Ammodramus henslowii	Henslow's Sparrow	Aves	Madison	N	S	Yes	Reference
Anas clypeata	Northern Shoveler	Aves	Madison	N	E		Reference
Anas discors	Blue-winged Teal	Aves	Madison	N	T		Reference
Ardea alba	Great Egret	Aves	Madison	N	T	Yes	Reference
Asio flammeus	Short-eared Owl	Aves	Madison	N	E	Yes	Reference

Asio otus	Long-eared Owl	Aves	Madison	N	E	Yes	Reference
Bubulcus ibis	Cattle Egret	Aves	Madison	N	S		Reference
Certhia americana	Brown Creeper	Aves	Madison	N	E	Yes	Reference
Chondestes grammacus	Lark Sparrow	Aves	Madison	N	T	Yes	Reference
Circus cyaneus	Northern Harrier	Aves	Madison	N	T	Yes	Reference
Cistothorus platensis	Sedge Wren	Aves	Madison	N	S	Yes	Reference
Corynorhinus rafinesquii	Rafinesque's Big-eared Bat	Mammalia	Madison	N	S	Yes	Reference
Cryptobranchus alleganiensis alleganiensis	Eastern Hellbender	Amphibia	Madison	N	E	Yes	Reference
Eumeces anthracinus	Coal Skink	Reptilia	Madison	N	T	Yes	Reference
Falco peregrinus	Peregrine Falcon	Aves	Madison	N	E	Yes	Reference
Fulica americana	American Coot	Aves	Madison	N	E		Reference
Gallinula galeata	Common Gallinule	Aves	Madison	N	T	Yes	Reference
Junco hyemalis	Dark-eyed Junco	Aves	Madison	N	S		Reference
Lophodytes cucullatus	Hooded Merganser	Aves	Madison	N	T	Yes	Reference
Mustela nivalis	Least Weasel	Mammalia	Madison	N	S		Reference
Myotis grisescens	Gray Myotis	Mammalia	Madison	E	T	Yes	Reference
Myotis septentrionalis	Northern Myotis	Mammalia	Madison	T	E		Reference
Nycticeius humeralis	Evening Bat	Mammalia	Madison	N	S	Yes	Reference
Pandion haliaetus	Osprey	Aves	Madison	N	S	Yes	Reference

Passerculus sandwichensis	Savannah Sparrow	Aves	Madison	N	S	Yes	Reference
Peucaea aestivalis	Bachman's Sparrow	Aves	Madison	N	E	Yes	Reference
Phalacrocorax auritus	Double-crested Cormorant	Aves	Madison	N	T		Reference
Podilymbus podiceps	Pied-billed Grebe	Aves	Madison	N	E	Yes	Reference
Pseudanophthalmus catoryctos	Lesser Adams Cave Beetle	Insecta	Madison	N	E		Reference
Pseudanophthalmus pholeter	Greater Adams Cave Beetle	Insecta	Madison	N	E		Reference
Rana pipiens	Northern Leopard Frog	Amphibia	Madison	N	S	Yes	Reference
Sitta canadensis	Red-breasted Nuthatch	Aves	Madison	N	E	Yes	Reference
Thryomanes bewickii	Bewick's Wren	Aves	Madison	N	S	Yes	Reference
Tyto alba	Barn Owl	Aves	Madison	N	S	Yes	Reference
Ursus americanus	American Black Bear	Mammalia	Madison	N	S	Yes	Reference
Vermivora chrysoptera	Golden-winged Warbler	Aves	Madison	N	T	Yes	Reference

38 species are listed

Reference 19

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If you are exposed to ammonia, many factors will determine whether you will be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider any other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS AMMONIA?

Ammonia is a chemical that is made both by humans and by nature. It is made up of one part nitrogen (N) and three parts hydrogen (H_3). The amount of ammonia manufactured every year by humans is almost equal to the amount produced by nature every year. However, when ammonia is found at a level that may cause concern, it was likely produced either directly or indirectly by humans.

Ammonia is a colorless gas with a very sharp odor. Ammonia in this form is also known as ammonia gas or anhydrous (“without water”) ammonia. Ammonia gas can also be compressed and becomes a liquid under pressure. The odor of ammonia is familiar to most people because ammonia is used in smelling salts, household cleaners, and window cleaning products. Ammonia easily dissolves in water. In this form, it is also known as liquid ammonia, aqueous ammonia, or ammonia solution. In water, most of the ammonia changes to the ionic form of ammonia, known as ammonium ions, which are represented by the formula NH_4^+ (an ion is an atom or a group of atoms that has acquired a net electric charge by gaining or losing one or more electrons). Ammonium ions are not gaseous and have no odor. Ammonia and ammonium ions can change back and forth in water. In wells, rivers, lakes, and wet soils, the ammonium form is the most common. Ammonia can also be combined with other substances to form ammonium compounds, including salts such as ammonium chloride, ammonium sulfate, ammonium nitrate, and others.

Ammonia is very important to plant, animal, and human life. It is found in water, soil, and air, and is a source of much needed nitrogen for plants and animals. Most of the ammonia in the environment comes from the natural breakdown of manure and dead plants and animals.

Eighty percent of all manufactured ammonia is used as fertilizer. A third of this is applied directly to soil as pure ammonia. The rest is used to make other fertilizers that contain ammonium compounds, usually ammonium salts. These fertilizers are used to provide nitrogen to plants. Ammonia is also used to manufacture synthetic fibers, plastics, and explosives. Many cleaning products also contain ammonia in the form of ammonium ions.

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Ammonia does not last very long in the environment. Because it is recycled naturally, nature has many ways of incorporating and transforming ammonia. In soil or water, plants and microorganisms rapidly take up ammonia. After fertilizer containing ammonia is applied to soil, the amount of ammonia in that soil decreases to low levels in a few days. In the air, ammonia will last about 1 week.

Ammonia has been found in air, soil, and water samples at hazardous waste sites. In the air near hazardous waste sites, ammonia can be found as a gas. Ammonia can also be found dissolved in ponds or other bodies of water at a waste site. Ammonia can be found attached to soil particles at hazardous waste sites. The average concentration of ammonia reported at hazardous waste sites ranges from 1 to 1,000 ppm in soil samples and up to 16 ppm in water samples.

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Ammonia is naturally produced and used by all mammals in their normal metabolism. Ammonia is produced within a person's body each day. Most of this ammonia is produced by organs and tissues, but some is produced by bacteria living inside our intestines.

Ammonia is found naturally in the environment. You may be exposed to ammonia by breathing air, eating food, or drinking water that contains it, or through skin contact with ammonia or ammonium compounds. Exposure to ammonia in the environment is most likely to occur by breathing in ammonia that has been released into the air.

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You can taste ammonia in water at levels of about 35 ppm. Lower levels than this occur naturally in food and water. Swallowing even small amounts of liquid ammonia in your household cleaner might cause burns in your mouth and throat. A few drops of liquid ammonia on the skin or in the eyes will cause burns and open sores if not washed away quickly. Exposure to larger amounts of liquid ammonia or ammonium ion in the eyes causes severe eye burns and can lead to blindness.

Outdoors, you may be exposed to high levels of ammonia gas in air from leaks and spills at production plants and storage facilities, and from pipelines, tank trucks, railcars, ships, and barges that transport ammonia. Higher levels of ammonia in air may occur when fertilizer with ammonia or ammonium compounds is applied to farm fields. After fertilizer is applied, the concentration of ammonia in soil can be more than 3,000 ppm; however, these levels decrease rapidly over a few days.

Indoors, you may be exposed to ammonia while using household products that contain ammonia. Some of these products are ammonia-cleaning solutions, window cleaners, floor waxes, and smelling salts.

Household and industrial cleaning solutions may contain ammonia, and use of these products at home or work may lead to exposure to ammonia. Both types of ammonia cleaning solutions are made by adding ammonia gas to water to form liquid ammonia. Household ammonia cleaners typically contain lower levels of ammonia (between 5 and 10%) compared to industrial cleaning solutions, which can contain higher levels of ammonia (up to 25%).

Farmers can be exposed to ammonia when they work with or apply fertilizers containing ammonia to fields. Farmers, cattle ranchers, and people who raise other types of livestock and/or poultry can be exposed to ammonia from decaying manure. Some manufacturing processes also use ammonia. Some older refrigeration units used ammonia as the refrigerant.

1.4 HOW CAN AMMONIA ENTER AND LEAVE MY BODY?

Ammonia can enter your body if you breathe in ammonia gas or if you swallow water or food containing ammonium salts. If you spill a liquid containing ammonia on your skin, a small amount of ammonia might enter your body through your skin; however, more ammonia will probably enter as you breathe ammonia gas from the spilled ammonia. After you breathe in ammonia, you breathe most of it out again. The ammonia that is retained in the body is changed into ammonium compounds and carried throughout the body in seconds. If you swallow ammonia in food or water, it will get into your bloodstream and be carried throughout your body in seconds. Most of the ammonia that enters your body from food or water rapidly changes into other substances that will not harm you. The rest of this ammonia leaves your body in urine within a couple of days.

1.5 HOW CAN AMMONIA AFFECT MY HEALTH?

Scientists use many tests to protect the public from harmful effects of toxic chemicals and to find ways for treating persons who have been harmed.

One way to learn whether a chemical will harm people is to determine how the body absorbs, uses, and releases the chemical. For some chemicals, animal testing may be necessary. Animal testing may also help identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method for getting information needed to make wise decisions that protect public health. Scientists have the responsibility to treat research animals with care and compassion. Scientists must comply with strict animal care guidelines because laws today protect the welfare of research animals.

Ammonia is a corrosive substance and the main toxic effects are restricted to the sites of direct contact with ammonia (i.e., skin, eyes, respiratory tract, mouth, and digestive tract). For example, if you spilled a bottle of concentrated ammonia on the floor, you would smell a strong ammonia odor; you might cough, and your eyes might water because of irritation. If you were exposed to very high levels of ammonia, you would experience more harmful effects. For example, if you walked into a dense cloud of ammonia or if your skin comes in contact with concentrated ammonia, your skin, eyes, throat, or lungs may be severely burned. These burns might be serious enough to cause permanent blindness, lung disease, or death. Likewise, if you accidentally ate or drank concentrated ammonia, you might experience burns in your mouth, throat, and stomach. There is no evidence that ammonia causes cancer. Ammonia has not been classified for carcinogenic effects by EPA, the Department of Health and Human Services (DHHS), or the International Agency for Research on Cancer (IARC). Ammonia can also have beneficial effects, such as when it is used as a smelling salt. Certain ammonium salts have long been used in veterinary and human medicine.

1.6 HOW CAN AMMONIA AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans.

Children are less likely than adults to be exposed to concentrated ammonia because most exposures to concentrated ammonia occur in occupational settings. Children can still be exposed in the same way as adults to ammonia gas from spills or leaks from ammonia tanks or pipelines, especially on farms where it is used as a fertilizer. Children can also be exposed to dilute ammonia solutions from household cleaners containing ammonia.

The effects of ammonia on children are likely to be the same as for adults. Ammonia is an irritant and the solution and gas can cause burns of the skin, eyes, mouth, and lungs. If a spill occurs, children may be exposed to ammonia for a longer time than adults because they may not leave the area as quickly.

There is no evidence that exposure to the levels of ammonia found in the environment causes birth defects or other developmental effects. It is not known whether ammonia can be transferred from a pregnant mother to a developing fetus through the placenta or from a nursing mother to her offspring through breast milk. One study in animals showed that exposure of mothers to very high levels of ammonia during pregnancy caused their newborn offspring to be smaller than normal, but this occurred at levels of ammonia that also affected the mothers.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO AMMONIA?

If your doctor finds that you have been exposed to significant amounts of ammonia, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

You can reduce your risk of exposure to ammonia by carefully using household products and by avoiding areas where ammonia is used or produced. At home, you can reduce your risk of exposure to ammonia by careful handling of any household products that contain ammonia. For example, some cleaning products contain ammonia; so when you use them, you should be sure that rooms are adequately ventilated during the time you are using them. Avoid ammonia-containing products in glass bottles since breakage could lead to a serious exposure. You should wear proper clothing and eye protection, because ammonia can cause skin burns and damage eyes if it is splashed on them. To lower the risk of your children being exposed to ammonia, you should tell them to stay out of the room when you are using it. While use of ammonia by a child is not recommended, any use by a child should be closely supervised by an adult.

You can also reduce your risk of exposure to ammonia by avoiding areas where it is being used. Ammonia is used to fertilize crops, so you can lower your exposure to ammonia by avoiding these areas when it is being applied. You can also lower your exposure to ammonia by avoiding places where it is produced. Ammonia is found in many animal wastes, and it may be present in high concentrations in the air in livestock buildings. You can lower your exposure to ammonia by avoiding these buildings, especially if large numbers of animals are inside.

If you are a worker who uses or applies ammonia for farming, you can reduce your exposure by using it according to the instructions and wearing proper clothing and protective gear. Be sure to follow all instructions and heed any warning statements.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO AMMONIA?

There are tests that measure ammonia/ammonium ion in blood and urine; however, these tests would probably not tell you whether you have been exposed because ammonia is normally found in the body. If you were exposed to harmful amounts of ammonia, you would notice it immediately because of the strong, unpleasant, and irritating smell, the strong taste, and because of skin, eye, nose, or throat irritation.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. The EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA) are some federal agencies that develop regulations for toxic substances. Recommendations provide valuable guidelines to protect public health, but cannot be enforced by law. The Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH) are two federal organizations that develop recommendations for toxic substances.

Regulations and recommendations can be expressed as "not-to-exceed" levels, that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value that is usually based on levels that affect animals; they are then adjusted to levels that will help protect humans. Sometimes these not-to-exceed levels differ among federal organizations because they used different exposure times (an 8-hour workday or a 24-hour day), different animal studies, or other factors.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for ammonia include the following:

EPA regulates the ammonia content in waste water released by several industries. Any discharges or spills of ammonia of 100 pounds or more, or of ammonium salts of 1,000 or 5,000 pounds (depending upon the compound), must be reported to EPA.

Some restrictions have been placed on levels of ammonium salts allowable in processed foods. FDA states that the levels of ammonia and ammonium compounds normally found in food do not pose a health risk. Maximum allowable levels in processed foods are as follows: 0.04–3.2% ammonium bicarbonate in baked goods, grain, snack foods, and reconstituted vegetables; 2.0%

ammonium carbonate in baked goods, gelatins, and puddings; 0.001% ammonium chloride in baked goods and 0.8% in condiments and relishes; 0.6–0.8% ammonium hydroxide in baked goods, cheeses, gelatins, and puddings; 0.01% monobasic ammonium phosphate in baked goods; and 1.1% dibasic ammonium phosphate in baked goods, 0.003% in nonalcoholic beverages, and 0.012% in condiments and relishes.

OSHA has set an 8-hour exposure limit of 25 ppm and a short-term (15-minute) exposure limit of 35 ppm for ammonia in the workplace. NIOSH recommends that the level in workroom air be limited to 50 ppm for 5 minutes of exposure.

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department, your regional Nuclear Regulatory Commission office, or contact ATSDR at the address and phone number below.

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

Toxicological profiles are also available on-line at www.atsdr.cdc.gov and on CD-ROM. You may request a copy of the ATSDR ToxProfiles™ CD-ROM by calling the information and technical assistance toll-free number at 1-888-42ATSDR (1-888-422-8737), by email at atsdric@cdc.gov, or by writing to:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE
Mailstop F-32
Atlanta, GA 30333
Fax: 1-770-488-4178

For-profit organizations may request a copy of final profiles from the following:

National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Phone: 1-800-553-6847 or 1-703-605-6000
Web site: http://www.ntis.gov/

Toxic Substances Portal - Ammonia

Toxic Substances Portal

- Ammonia
  - ToxFAQs™
  - Public Health Statement
  - Toxicological Profile
  - ToxGuide
  - Medical Management Guidelines (MMG) for Acute Chemical Exposure
- ... More Resources

Environmental Health Substances Map

Select a state:
Alabama Get Map

This map displays locations where *Ammonia* is known to be present.

On This Page

Public Health Statement for Ammonia

(*Amoníaco*)

September 2004

CAS#: 7664-41-7

PDF Version, 69 KB

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Children are less likely than adults to be exposed to concentrated ammonia because most exposures to concentrated ammonia occur in occupational settings. Children can still be exposed in the same way as adults to ammonia gas from spills or leaks from ammonia tanks or pipelines, especially on farms where it is used as a fertilizer. Children can also be exposed to dilute ammonia solutions from household cleaners containing ammonia.

The effects of ammonia on children are likely to be the same as for adults. Ammonia is an irritant and the solution and gas can cause burns of the skin, eyes, mouth, and lungs. If a spill occurs, children may be exposed to ammonia for a longer time than adults because they may not leave the area as quickly.

There is no evidence that exposure to the levels of ammonia found in the environment causes birth defects or other developmental effects. It is not known whether ammonia can be transferred from a pregnant mother to a developing fetus through the placenta or from a nursing mother to her offspring through breast milk. One study in animals showed that exposure of mothers to very high levels of ammonia during pregnancy caused their newborn offspring to be smaller than normal, but this occurred at levels of ammonia that also affected the mothers.

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1.7 How can families reduce the risk of exposure to ammonia?

If your doctor finds that you have been exposed to significant amounts of ammonia, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

You can reduce your risk of exposure to ammonia by carefully using household products and by avoiding areas where ammonia is used or produced. At home, you can reduce your risk of exposure to ammonia by careful handling of any household products that contain ammonia. For example, some cleaning products contain ammonia; so when you use them, you should be sure that rooms are adequately ventilated during the time you are using them. Avoid ammonia-containing products in glass bottles since breakage could lead to a serious exposure. You should wear proper clothing and eye protection, because ammonia can cause skin burns and damage eyes if it is splashed on them. To lower the risk of your children being exposed to ammonia, you should tell them to stay out of the room when you are using it. While use of ammonia by a child is not recommended, any use by a child should be closely supervised by an adult.

You can also reduce your risk of exposure to ammonia by avoiding areas where it is being used. Ammonia is used to fertilize crops, so you can lower your exposure to ammonia by avoiding these areas when it is being applied. You can also lower your exposure to ammonia by avoiding places where it is produced. Ammonia is found in many animal wastes, and it may be present in high concentrations in the air in livestock buildings. You can lower your exposure to ammonia by avoiding these buildings, especially if large numbers of animals are inside.

If you are a worker who uses or applies ammonia for farming, you can reduce your exposure by using it according to the instructions and wearing proper clothing and protective gear. Be sure to follow all instructions and heed any warning statements.

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1.8 Is there a medical test to determine whether I have been exposed to ammonia?

There are tests that measure ammonia/ammonium ion in blood and urine; however, these tests would probably not tell you whether you have been exposed because ammonia is normally found in the body. If you were exposed to harmful amounts of ammonia, you would notice it immediately because of the strong, unpleasant, and irritating smell, the strong taste, and because of skin, eye, nose, or throat irritation.

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1.9 What recommendations has the federal government made to protect human health?

The federal government develops regulations and recommendations to protect public health. Regulations *can* be enforced by law. The EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA) are some federal agencies that develop regulations for toxic substances. Recommendations provide valuable guidelines to protect public health, but *cannot* be enforced by law. The Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH) are two federal organizations that develop recommendations for toxic substances.

Regulations and recommendations can be expressed as "not-to-exceed" levels, that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value that is usually based on levels that affect animals; they are then adjusted to levels that will help protect humans. Sometimes these not-to-exceed levels differ among federal organizations because they used different exposure times (an 8-hour workday or a 24-hour day), different animal studies, or other factors.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for ammonia include the following:

EPA regulates the ammonia content in waste water released by several industries. Any discharges or spills of ammonia of 100 pounds or more, or of ammonium salts of 1,000 or 5,000 pounds (depending upon the compound), must be reported to EPA.

Some restrictions have been placed on levels of ammonium salts allowable in processed foods. FDA states that the levels of ammonia and ammonium compounds normally found in food do not pose a health risk. Maximum allowable levels in processed foods are as follows: 0.04-3.2% ammonium bicarbonate in baked goods, grain, snack foods, and reconstituted vegetables; 2.0% ammonium carbonate in baked goods, gelatins, and puddings; 0.001% ammonium chloride in baked goods and 0.8% in condiments and relishes; 0.6-0.8% ammonium hydroxide in baked goods, cheeses, gelatins, and puddings; 0.01% monobasic ammonium phosphate in baked goods; and 1.1% dibasic ammonium phosphate in baked goods, 0.003% in nonalcoholic beverages, and 0.012% in condiments and relishes.

OSHA has set an 8-hour exposure limit of 25 ppm and a short-term (15-minute) exposure limit of 35 ppm for ammonia in the workplace. NIOSH recommends that the level in workroom air be limited to 50 ppm for 5 minutes of exposure.

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References

Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Toxicological profile for Ammonia. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

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Where can I get more information?

If you have questions or concerns, please contact your community or state health or environmental quality department or:

For more information, contact:
Agency for Toxic Substances and Disease Registry
Division of Toxicology and Human Health Sciences
1600 Clifton Road NE, Mailstop F-57
Atlanta, GA 30329-4027
Phone: 1-800-CDC-INFO · 888-232-6348 (TTY)
Email: Contact CDC-INFO

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

Information line and technical assistance:
Phone: 888-422-8737

To order toxicological profiles, contact:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: 800-553-6847 or 703-605-6000

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The information contained here was correct at the time of publication. Please check with the appropriate agency for any changes to the regulations or guidelines cited.

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HRS Scoring

****** CONFIDENTIAL ******
******PRE-DECISIONAL DOCUMENT ******
****** SUMMARY SCORESHEET ******
****** FOR COMPUTING PROJECTED HRS SCORE ******

****** Do Not Cite or Quote ******

Site Name: Richmond Ice Plant

Region: Region 4

Scenario Name: pond area worst case

City, County, State: Richmond/ Madison, Kentucky

Evaluator: Wesley Turner

EPA ID#: KYD042943217

Date: 06/09/2016

Lat/Long: 37:44:27,-84:17:14

Congressional District:

This Scoresheet is for: PA

Scenario Name: pond area worst case

Description: This scenario is based on the entire pond area associated with the Ice Plant. Used oil constituents were used as the COCs and lead

	S pathway	S^2 pathway
Ground Water Migration Pathway Score (S_{gw})	0.11	0.01
Surface Water Migration Pathway Score (S_{sw})	33.06	1092.96
Soil Exposure Pathway Score (S_s)	0.0	0.0
Air Migration Score (S_a)	0.0	0.0
$S^2_{gw} + S^2_{sw} + S^2_s + S^2_a$		1092.98
$(S^2_{gw} + S^2_{sw} + S^2_s + S^2_a)/4$		273.24
$/ (S^2_{gw} + S^2_{sw} + S^2_s + S^2_a)/4$		16.53

Pathways not assigned a score (explain):

TABLE 3-1 --GROUND WATER MIGRATION PATHWAY SCORESHEET

Factor categories and factors	Maximum Value	Value Assigned	
Aquifer Evaluated: General Groundwater			
Likelihood of Release to an Aquifer:			
1. Observed Release	550	550.0	
2. Potential to Release:			
2a. Containment	10	0.0	
2b. Net Precipitation	10	0.0	
2c. Depth to Aquifer	5	1.0	
2d. Travel Time	35	1.0	
2e. Potential to Release [lines 2a(2b + 2c + 2d)]	500	0.0	
3. Likelihood of Release (higher of lines 1 and 2e)	550		550.0
Waste Characteristics:			
4. Toxicity/Mobility	(a)	1.0	
5. Hazardous Waste Quantity	(a)	100.0	
6. Waste Characteristics	100		3.0
Targets:			
7. Nearest Well	(b)	0.0	
8. Population:			
8a. Level I Concentrations	(b)	0.0	
8b. Level II Concentrations	(b)	0.0	
8c. Potential Contamination	(b)	0.0	
8d. Population (lines 8a + 8b + 8c)	(b)	0.0	
9. Resources	5	5.0	
10. Wellhead Protection Area	20	0.0	
11. Targets (lines 7 + 8d + 9 + 10)	(b)		5.0
Ground Water Migration Score for an Aquifer:			
12. Aquifer Score [(lines 3 x 6 x 11)/82,5000][c]	100		0.11
Ground Water Migration Pathway Score:			
13. Pathway Score (S_{gw}), (highest value from line 12 for all aquifers evaluated)[c]	100		0.0

[a] Maximum value applies to waste characteristics category
[b] Maximum value not applicable
[c] Do not round to nearest integer

TABLE 4-1 --SURFACE WATER OVERLAND/FLOOD MIGRATION COMPONENT SCORESHEET			
Factor categories and factors	Maximum Value	Value Assigned	
Watershed Evaluated: Kentucky River			
Drinking Water Threat			
Likelihood of Release:			
1. Observed Release	550	550.0	
2. Potential to Release by Overland Flow:			
2a. Containment	10	0.0	
2b. Runoff	10	0.0	
2c. Distance to Surface Water	5	3.0	
2d. Potential to Release by Overland Flow [lines 2a(2b + 2c)]	35	0.0	
3.Potential to Release by Flood:			
3a. Containment (Flood)	10	0.0	
3b. Flood Frequency	50	0.0	
3c. Potential to Release by Flood (lines 3a x 3b)	500	0.0	
4. Potential to Release (lines 2d + 3c, subject to a maximum of 500)	500	0.0	
5. Likelihood of Release (higher of lines 1 and 4)	550		550.0
Waste Characteristics:			
6. Toxicity/Persistence	(a)	10000.0	
7. Hazardous Waste Quantity	(a)	10.0	
8. Waste Characteristics	100		18.0
Targets:			
9. Nearest Intake	50	0.0	
10. Population:			
10a. Level I Concentrations	(b)	0.0	
10b. Level II Concentrations	(b)	0.0	
10c. Potential Contamination	(b)	0.5	
10d. Population (lines 10a + 10b + 10c)	(b)	0.5	
11. Resources	5	0.0	
12. Targets (lines 9 + 10d + 11)	(b)		0.5
Drinking Water Threat Score:			
13. Drinking Water Threat Score [(lines 5x8x12)/82,500, subject to a max of 100]	100		0.06
Human Food Chain Threat			
Likelihood of Release:			
14. Likelihood of Release (same value as line 5)	550		550.0
Waste Characteristics:			
15. Toxicity/Persistence/Bioaccumulation	(a)	5.0E8	
16. Hazardous Waste Quantity	(a)	10.0	
17. Waste Characteristics	1000		180.0
Targets:			
18. Food Chain Individual	50	20.0	
19. Population			
19a. Level I Concentration	(b)	0.0	
19b. Level II Concentration	(b)	0.0	
19c. Potential Human Food Chain Contamination	(b)	0.0	
19d. Population (lines 19a + 19b + 19c)	(b)	0.0	
20. Targets (lines 18 + 19d)	(b)		20.0
Human Food Chain Threat Score:			
21. Human Food Chain Threat Score [(lines 14x17x20)/82500, subject to max of 100]	100		24.0
Environmental Threat			
Likelihood of Release:			
22. Likelihood of Release (same value as line 5)	550		550.0
Waste Characteristics:			
23. Ecosystem Toxicity/Persistence/Bioaccumulation	(a)	5.0E8	
24. Hazardous Waste Quantity	(a)	10.0	
25. Waste Characteristics	1000		180.0

Targets:			
26. Sensitive Environments			
26a. Level I Concentrations	(b)	0.0	
26b. Level II Concentrations	(b)	0.0	
26c. Potential Contamination	(b)	7.5	
26d. Sensitive Environments (lines 26a + 26b + 26c)	(b)	7.5	
27. Targets (value from line 26d)	(b)		7.5
Environmental Threat Score:			
28. Environmental Threat Score [(lines 22x25x27)/82,500 subject to a max of 60]	60		9.0
Surface Water Overland/Flood Migration Component Score for a Watershed			
29. Watershed Score[c] (lines 13+21+28, subject to a max of 100}	100		33.06
Surface Water Overland/Flood Migration Component Score			
30. Component Score (S_{of})[c] (highest score from line 29 for all watersheds evaluated)	100		33.06

[a] Maximum value applies to waste characteristics category
[b] Maximum value not applicable
[c] Do not round to nearest integer

TABLE 4-25 --GROUND WATER TO SURFACE WATER MIGRATION COMPONENT SCORESHEET			
Factor categories and factors	Maximum Value	Value Assigned	
Watershed Evaluated: Kentucky River			
Drinking Water Threat			
Likelihood of Release to an Aquifer:			
1. Observed Release	550	0.0	
2. Potential to Release:			
2a. Containment	10	0.0	
2b. Net Precipitation	10	0.0	
2c. Depth to Aquifer	5	0.0	
2d. Travel Time	35	0.0	
2e. Potential to Release [lines 2a(2b + 2c + 2d)]	500	0.0	
3. Likelihood of Release (higher of lines 1 and 2e)	550		0.0
Waste Characteristics:			
4. Toxicity/Mobility	(a)	0.0	
5. Hazardous Waste Quantity	(a)	0.0	
6. Waste Characteristics	100		0.0
Targets:			
7. Nearest Well	(b)	0.0	
8. Population:			
8a. Level I Concentrations	(b)	0.0	
8b. Level II Concentrations	(b)	0.0	
8c. Potential Contamination	(b)	0.0	
8d. Population (lines 8a + 8b + 8c)	(b)	0.0	
9. Resources	5	0.0	
10. Targets (lines 7 + 8d + 9)	(b)		0.0
Drinking Water Threat Score:			
11. Drinking Water Threat Score ([lines 3 x 6 x 10]/82,500, subject to max of 100)	100		0.0
Human Food Chain Threat			
Likelihood of Release:			
12. Likelihood of Release (same value as line 3)	550	0.0	
Waste Characteristics:			
13. Toxicity/Mobility/Persistence/Bioaccumulation	(a)	0.0	
14. Hazardous Waste Quantity	(a)	0.0	
15. Waste Characteristics	1000		0.0
Targets:			
16. Food Chain Individual	50	0.0	
17. Population			
17a. Level I Concentration	(b)	0.0	
17b. Level II Concentration	(b)	0.0	
17c. Potential Human Food Chain Contamination	(b)	0.0	
17d. Population (lines 17a + 17b + 17c)	(b)	0.0	
18. Targets (lines 16 + 17d)	(b)		0.0
Human Food Chain Threat Score:			
19. Human Food Chain Threat Score [(lines 12x15x18)/82,500,suject to max of 100]	100		0.0
Environmental Threat			
Likelihood of Release:			
20. Likelihood of Release (same value as line 3)	550		0.0
Waste Characteristics:			
21. Ecosystem Toxicity/Persistence/Bioaccumulation	(a)	0.0	
22. Hazardous Waste Quantity	(a)	0.0	
23. Waste Characteristics	1000		0.0
Targets:			
24. Sensitive Environments			
24a. Level I Concentrations	(b)	0.0	
24b. Level II Concentrations	(b)	0.0	

24c. Potential Contamination	(b)	0.0	
24d. Sensitive Environments (lines 24a + 24b + 24c)	(b)	0.0	
25. Targets (value from line 24d)	(b)		0.0
Environmental Threat Score:			
26. Environmental Threat Score [(lines 20x23x25)/82,500 subject to a max of 60]	60		0.0
Ground Water to Surface Water Migration Component Score for a Watershed			
27. Watershed Score[c] (lines 11 + 19 + 28, subject to a max of 100)	100		0.0
28. Component Score (S_{gs})[c] (highest score from line 27 for all watersheds evaluated, subject to a max of 100)	100		0.0

[a] Maximum value applies to waste characteristics category
[b] Maximum value not applicable
[c] Do not round to nearest integer

TABLE 5-1 --SOIL EXPOSURE PATHWAY SCORESHEET			
Factor categories and factors	Maximum Value	Value Assigned	
Likelihood of Exposure:			
1. Likelihood of Exposure	550		
Waste Characteristics:			
2. Toxicity	(a)	0.0	
3. Hazardous Waste Quantity	(a)		
4. Waste Characteristics	100		0.0
Targets:			
5. Resident Individual	50		
6. Resident Population:			
6a. Level I Concentrations	(b)	0	
6b. Level II Concentrations	(b)		
6c. Population (lines 6a + 6b)	(b)		
7. Workers	15	0.0	
8. Resources	5		
9. Terrestrial Sensitive Environments	(c)		
10. Targets (lines 5 + 6c + 7 + 8 + 9)	(b)		0.0
Resident Population Threat Score			
11. Resident Population Threat Score (lines 1 x 4 x 10)	(b)		0.0
Nearby Population Threat			
Likelihood of Exposure:			
12. Attractiveness/Accessibility	100	10.0	
13. Area of Contamination	100	20.0	
14. Likelihood of Exposure	500		5.0
Waste Characteristics:			
15. Toxicity	(a)	0.0	
16. Hazardous Waste Quantity	(a)	0.0	
17. Waste Characteristics	100		0.0
Targets:			
18. Nearby Individual	1	1.0	
19. Population Within 1 Mile	(b)	6.60000000000 00005	
20. Targets (lines 18 + 19)	(b)		7.6
Nearby Population Threat Score			
21. Nearby Population Threat (lines 14 x 17 x 20)	(b)		0.0
Soil Exposure Pathway Score:			
22. Pathway Score[d] (S_s), [lines (11+21)/82,500, subject to max of 100]	100		0.0

[a] Maximum value applies to waste characteristics category
[b] Maximum value not applicable
[c] No specific maximum value applies to factor. However, pathway score based solely on terrestrial sensitive environments is limited to a maximum of 60
[d] Do not round to nearest integer

TABLE 6-1 --AIR MIGRATION PATHWAY SCORESHEET		
Factor categories and factors	Maximum Value	Value Assigned
Likelihood of Release:		
1. Observed Release	550	
2. Potential to Release:		
2a. Gas Potential to Release	500	
2b. Particulate Potential to Release	500	
2c. Potential to Release (higher of lines 2a and 2b)	500	
3. Likelihood of Release (higher of lines 1 and 2c)	550	
Waste Characteristics:		
4. Toxicity/Mobility	(a)	
5. Hazardous Waste Quantity	(a)	
6. Waste Characteristics	100	
Targets:		
7. Nearest Individual	50	
8. Population:		
8a. Level I Concentrations	(b)	
8b. Level II Concentrations	(b)	
8c. Potential Contamination	(c)	
8d. Population (lines 8a + 8b + 8c)	(b)	
9. Resources	5	
10. Sensitive Environments:		
10a. Actual Contamination	(c)	
10b. Potential Contamination	(c)	
10c. Sensitive Environments (lines 10a + 10b)	(c)	
11. Targets (lines 7 + 8d + 9 + 10c)	(b)	
Air Migration Pathway Score:		
12. Pathway Score (S_a) [(lines 3 x 6 x 11)/82,500][d]	100	

[a] Maximum value applies to waste characteristics category
[b] Maximum value not applicable
[c] No specific maximum value applies to factor. However, pathway score based solely on sensitive environments is limited to a maximum of 60.
[d] Do not round to nearest integer

HRS Quickscore notes- Richmond Ice Company

This scenario assumes an observed release. The Air Migration Pathway was not scored. The site score for the observed release worst case scenario for the pond area was 16.53.

Source

The source used was contaminated soil and a release of used oil to the surface water in the pond.

Hazardous Substances

The PA conducted in 1987 assumed toluene to be the typical contaminant. For the purposes of this SRA, polycyclic aromatic hydrocarbons (PAHs) and lead were chosen as the primary constituents of concern. The ice plant employed ammonia in the ice making process; therefore it will be considered also (Ref. 5)

For the purposes of this report the black oily substance is assumed to be used oil and PAHs and lead assumed to be the COCs. Ammonia was also considered but based on information from ASTDR the residence time for an ammonia leak would be on the order of a few weeks at best since it is metabolized quickly by many organisms in the environment (Ref. 19).

Soil Exposure Pathway

No information concerning the dimensions of the oily substance staining the banks could be found; therefore the entire bank perimeter was evaluated using used oil (PAHs) and lead as the primary constituents of concern.

Air Migration Pathway

The Air Migration Pathway was not evaluated since there were no active emissions.

Surface Water Pathway

Since the substance was seen on the surface of the soil and the water in the pond, an observed release was assumed in this scenario. No analytical data exists for the release.

Groundwater Pathway

There are no groundwater (drinking water) users in the four mile radius and the surrounding area is supplied by a municipal drinking water supply.

The release occurred in 1973 but the score was generated based on a current release as a worst case scenario.

Summary

This scenario does not support investigation under CERCLA.